SCIENCE

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CONTENTS

MSS. Intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

BOTANY AND ITS ECONOMIC APPLICATIONS[1]

SINCE our last meeting the Great War has continued to hold chief place in our lives and thoughts, and in various ways, and to a greater or less degree, has influenced our work. In the case of many botany has had for the time being to be set aside, while others have been able to devote only a part of their time to scientific work. On the other hand, it is gratifying to note that some have been able to render helpful service on lines more or less directly connected with their own science. The trained botanist has shown that he may be an eminently adaptable person, capable, after short preparation on special lines, of taking up positions involving scientific investigation of the highest importance from the standpoints of medicine and hygiene.

We have to regret the loss of a promising young Cambridge botanist, Alfred Stanley Marsh, who has made the supreme sacrifice for his country. Happily, in other cases lives have been spared and we are able to welcome their return to the service of botany.

In common with our fellow-botanists throughout the world, we have learned with sorrow of the death of one of the kindliest and most versatile exponents of the science, Count Solms Laubach, whom we have welcomed in years past as a guest of our section.

May I also refer to the recognition recently given by the Royal Society to the

[1] Address of the president of the Botanical Section of the British Association for the Advancement of Science, Section K, Newcastle-on-Tyne, 1916.

services of two of our colonial botanists? Mr. W. H. Maiden, of Sydney, who has done so much in Australia for the development of botany and its applications in his position as government botanist and director of the Botanic Gardens at Sydney, and whose kindness some of us have good cause to remember on the occasion of the visit of this association to Sydney in 1914; and Professor W. H. Pearson, of Cape Town, who is doing useful work of botanical exploration in Southwest Africa.

A little more than two years ago, during the enforced but pleasant leisure of our passage across the Indian Ocean to Australia, I was discussing with our president for the year the possibility of a war with Germany. He was confident that sooner or later it was bound to come. I was doubtful. "But what will prevent it?" asked my companion. "The common sense of the majority," was my reply. He was right and I was wrong, but I think he was only less surprised than myself when next evening we heard, by wireless, rumors of the outbreak of what rapidly developed into the great European war. But even a few weeks later, when Germany was pressing westwards, and the very existence of our Empire was threatened, we hardly began to appreciate what it would mean, and we still talked of the possibility of an International Botanical Congress in 1915.

We know more now, and I need not apologize for considering in my address the part which botanists can take in the near future, especially after the war. For one thing at least is certain, we are two years nearer the end than when it began, and let us see to it that we are not as backward in preparing for post-war as we were for war problems.

Some months ago the various sectional committees received a request to consider what could be done in their respective sections to meet problems which would arise after the war. Your committee met and discussed the matter, with the result that a set of queries was sent round to representative botanists asking that suggestions might be presented for consideration by the committee. A number of suggestions were received of a very varied kind, indicating that in the opinion of many botanists at any rate much might be done to utilize our science and its trained workers in the interests of the state and empire. Your committee decided to arrange for reports to be prepared on several of the more important aspects by members who were specially fitted to discuss these aspects, and these will be presented in the course of the meeting. These reports will, I am convinced, be of great value, and may lead to helpful discusssion; they may also open up the way to useful work.

For my own part, while I might have preferred to consider in my address some subject of more purely botanical interest, I felt that under the circumstances an academic discourse would be out of place, and that I too must endeavor to do something to effect a more cordial understanding between botany and its economic applications.

For many of us this means the breaking of new ground. We have taken up the science because we loved it, and if we have been able to shed any light on its numerous problems the work has brought its own reward. But some of us have on occasion been brought into touch with economic problems, and such must have felt how inadequate was our national equipment for dealing with some of these. In recent years we have made several beginnings, but these beginnings must expand mightily if present and future needs are to be adequately met and if we are determined to make the best use of the material to our hand.

Whether or no we have been living for the past forty years in a fools' paradise, it is certain that our outlook will be widely different after the war, and may the stimulus of a changed environment find us ready to respond!

Sacrifice must be general, and the botanist must do his bit. This need not mean giving up the pursuit of pure science, but it should mean a heavy specialization in those lines of pure science which will help to alleviate the common burden, will render our country and the Empire less dependent on external aid, and knit more closely its component parts.

It may be convenient to consider, so far as they are separable, home and imperial problems.

Without trenching on the domain of economics, we may assume that increased production of foodstuffs, timber and other economic products will be desirable. The question has been raised as to the possibility of increasing at the same time industrial and agricultural development. But as in industry perfection of machinery allows a greater output with a diminished number of hands, so in agriculture and horticulture perfection of the machinery of organization and equipment will have the same result.

There are three factors in which botanists are primarily interested—the plant, the soil, and the worker.

The improvement of the plant from an economic point of view implies the cooperation of the botanist and the plant-breeder. The student of experimental genetics, by directing his work to plants of economic value, is able, with the help of the resources of agriculture and horticulture, to produce forms of greater economic value, kinds best suited to different localities and ranges of climate, those most immune to disease and of the highest food value. Let the practical man formulate the ideal, and then let the scientist be invited to supply it. Much valuable work has been done on these lines, but there is still plenty of scope for the organized Mendelian study of plants of economic importance. It is a very large subject, and we are hoping to hear more about it before we separate.

A minor example occurs to me. Do the prize vegetables which one sees at shows and portrayed in the catalogues represent the best products from an economic point of view; in other words, is the standard of excellence one which considers solely their value as foodstuffs? A chemico-botanical examination would determine at what point increase in size becomes disproportionate to increase in food value, and thus correct the standard from an economic point of view. And, presumably, the various characters which imply greater or less feeding value offer scope for the work of the Mendelian.

The subject of intensive cultivation offers a series of problems which are primarily botanical. It would be a useful piece of investigation to work out the most profitable series which can be grown from year to year with the least expenditure on manures and the minimum of liability to disease. A comparatively small area would suffice for the work.

The introduction of new plants of economic value is within the range of possibility; our repertoire has increased in recent years, but an exhaustive study of food plants and possible food plants for man and stock would doubtless yield good results. It is matter of history that the introduction of the tea plant into further India was the result of observations by Fortune, a botanical collector. The scientific botanist may find pleasant relaxation in the smaller problems of horticulture.

We have heard much lately as to the growing of medicinal plants, and experience would indicate that here is opportunity for investigation, and, unless due care is taken, also danger of waste of time, money and effort. A careful systematic study of species, varieties and races is in some cases desirable in order to ensure the growth of the most productive or valuable plant, as in the case of the Aconites; and such a study might also reveal useful substitutes or additions. Here the cooperation between the scientific worker and the commercial man is imperative. I have recently been interested to hear that the special properties of medicinal plants are to be subjected to experiment on Mendelian lines.

During the past year there has been considerable activity in the collecting of wild specimens of various species of medicinal value, frequently, one fears, involving loss of time and waste of plants, owing to want of botanical or technical knowledge and lack of organization. In this connection a useful piece of botanical work has recently been carried out by Mr. W. W. Smith, of Edinburgh, on the collection of sphagnum for the preparation of surgical dressings. The areas within the Edinburgh district have been mapped and classified so as to indicate their respective values in terms of yield of sphagnum. By the indication of the most suitable areas, the suitability depending on extent of area, density of growth, freedom of admixture of grass or heather, as well as facility of transport and provision of labor, the report is of great economic value. The continuity of supply is an important question, and one which should be borne in mind by collectors of medicinal plants generally. And while it is not the most favorable time to voice the claims of protection of wild plants, one may express the hope that the collector's zeal will be accompanied by discretion.

The advantages arising from a closer cooperation between the practical man and the botanist is illustrated by the research laboratories recently organized by the Royal Horticultural Society at Wisley. Such an institution forms a common meeting-ground for the grower of plants and the botanist. The former sets the problems, and the latter takes them in hand under conditions approaching the ideal and with the advantages of mutual discussion and criticism. Institutions such as these will give ample opportunity to the enthusiastic young botanist who is anxious to embark on work of investigation. The student of plant physiology will find here work of great interest. The grower has perforce gained a great deal of information as to the behavior of his plants under more or less artificial conditions, but he is unable to analyze these conditions, and the cooperation of the physiologist is an invaluable help. Experiments in the growth of plants under the influence of high-tension electricity are at the present time being carried out at Wisley. Such experiments may be conducted anywhere where land and power are available, but it is obviously advantageous that they should be conducted by an expert plant-physiologist versed in scientific method and not directly interested in the result. Dr. Keeble's recent series of lectures on Modern Horticulture at the Royal Institution deal with matter which is full of interest to the botanist. For instance, he shows how the work of continental botanists on the forcing of plants has indicated methods, in some cases simple and inexpensive, which have proved of considerable commercial value, and that there is evidently scope for work in this direction, which, while of interest to the plant-physiologist, may be also of general utility.

The subject of the soil offers problems

to the botanist as well as to the chemist and proto-zoologist. In the plant we are dealing with a living organism, not a machine; and an adequate knowledge of the organism is essential to a proper study of its nutrition and growth. The facility with which a considerable sum of money was raised just before the war to improve the equipment at Rothamsted, where work was being done on these lines, indicates that practical men are ready to come forward with financial help if work which promises to yield results of economic importance is being seriously carried out. And it is significant of the attitude of botanists to such problems that there is only one trained botanist on the staff of this institution.

The study of manures and their effect on the plant should attract the botanist as well as the chemist. In this connection I may refer to Mr. Martin Sutton's recent work at Reading on the effects of radioactive ores and residues on plant life. A series of experiments was carried out in two successive years with various subjects selected for the different character of their produce, and including roots, tubers, bulbs, foliage and fruit. From the immediate point of view of agriculture and horticulture the results were negative; the experiments gave no hope of the successful employment of radium as an aid to either the farmer or the gardener. Speaking generally, the produce from a given area was less when the soil had been treated with pure radium bromide, or various proprietary radioactive fertilizers, than when treated with farmyard manure or a complete fertilizer; while the cost of dressing was very much greater. To quote Mr. Sutton's concluding words:

> The door is still open to the investigator in search of a plant fertilizer which will prove superior to farmyard dung or the many excellent artificial preparations now available.

But though the immediate result was unsatisfactory to the grower, there were several points of interest which would have appealed to the botanist who was watching the course of the experiments, and which, if followed up, might throw light on the effect of radium on plant-life and lead in the end to some useful result. As Mr. Sutton points out, many of the results were "contradictory," while a close examination of the trial notes, together with the records of weights, will furnish highly interesting problems. For instance, there was evidence in some cases that germination was accelerated by the presence of radium, though subsequent growth was retarded; and the fact that in several of the experiments plants dressed with a complete fertilizer in addition to radium have not done so well as those dressed with the fertilizer only may be regarded as corroborating M. Truffaut's suggestion that radium might possess the power of releasing additional nitrogen in the soil for the use of plants, and that the plants in question were suffering from an excess of nitrogen. Certain remarkable variations between the duplicate unmanured control plots in several of the experiments led to the suggestion that radium emanations may have some effect, apparently a beneficial one. I have quoted these experiments as an example of a case where the cooperation of the botanist and the practical man might lead to useful results, and at the same time afford work of much interest to the botanist.

As an introduction to such work university professors might encourage their advanced students to spend their long vacation in a large nursery or botanic garden where experimental work is done.

As regards the worker in agriculture and horticulture, how can the botanist help? Apart from well-staffed and well-equipped schools of agriculture and horticulture,

which require the botanist's assistance, a wider dissemination of the botanist would be advantageous. Properly trained botanists distributed through the country with their eyes open might be a valuable asset in the improvement of production; botanist and cultivator might be mutually helpful; the former would meet problems at first hand, and the latter should be encouraged by the cooperation. A kind of first-aid class suggests itself, run by a teacher with a good elementary knowledge of botany, upon which has been erected a general knowledge of horticultural operations. This would afford a vocation for students of scientific bent who can not spare the time for a long university course. Some of us may remember the courses arranged by various County Councils thirty years or so ago, financed by the whiskey money, out of which have grown some useful permanent educational institutions. But these courses were often barren of result, owing partly to insufficient "sympathy" between the lecturer and his audience. A young man fresh from the university who was waiting for a more permanent job was brought into touch with the practical man in the lecture hall, and the contact was, so to speak, not good. Between the two was a gulf across which the lecturer shouted, and his words often conveyed little meaning to those on the other side. A great deal of money must have been spent with incommensurate results.

On the other hand, we must be careful to work economically and not wear out high-class tools on rough work. I think there is some danger of this in connection with certain courses in horticulture for women. Girls who have had a good general education enter, at the age of seventeen or eighteen, on a course of study, lasting for two or three years, of horticultural methods and the kindred sciences. So far, good; but after all this training the finished product should aspire to something more than market gardening in competition with the man who left school at twelve or fourteen, has learned his business practically, and has a much lower standard of living.

The utilization of waste lands is a big subject and trenches on the domain of economics. But important botanical problems are involved and careful ecological study will prepare the way for serious experimental work. The study of the growth of plants in alien situations is fraught with so many surprises and apparent contradictions that successful results may be looked for in most unlikely situations. I remember a striking instance near Lake Tarawera, in the North Island of New Zealand. The area in question had been completely devastated in the great eruption of Mount Tarawera in 1886, the ground being covered with ash to a depth of several feet. When I saw it two years ago the vegetation of a considerable area was almost purely central European. The trees were poplar, *Robinia* and elder, with an undergrowth of dog-rose, bramble, etc. I was not able to find out the recent history of the locality and there were very few signs of habitation, but it was not the kind of vegetation one would expect to find growing so naturally and freely in such a locality. But the subject of utilization of waste lands will occupy us later.

The study of the diseases to which plants are liable, and their prevention and cure, offers a wide and increasing field for inquiry, and demands a larger supply of trained workers and a more definite and special system of training. For the study of those which are due to fungi it is obviously essential that a thorough general knowledge of fungi and laboratory methods should be acquired, preferably at some Pathological Institution which would also

be in touch with the cultivator and naturally approached by those requiring advice and help in connection with disease, on the same principle that a medical school is attached to a hospital. An important part of the training should be the study of the disease in the field and the conditions under which it arises and flourishes. From the point of view of mycology much useful scientific work remains to be done on the life history of the fungi which are or may be the causes of disease. The study of preventive methods must obviously be carried out in the field, and, while these are mainly mechanical processes, they need careful supervision; the question of the subsequent gathering and disposal of a crop must not be overlooked. Experiments in the use of dust instead of spray as a preventive of fungous and insect attack have recently been carried out in America. Other plant diseases afford problems for the physiologist, who is a necessary part of the equipment of the pathological institute.

The anatomical and chemical study of timbers might with advantage occupy a greater number of workers. The matter is of great economic importance. Questions of identity are continually arising, and in the present vague state of our knowledge it is often difficult or impossible to give a satisfactory answer. Samples of timber are put on the market shipped, say, from West Africa under some general name such as mahogany; the importer does not supply leaves and flowers for purpose of identification, and in the present incomplete state of our knowledge it is often impossible to make more than a vague attempt at determination. Or a merchant brings a sample which has been sent from X as Y, which it obviously is not; but what is it, whence does it probably come, and what supply of it is likely to be forthcoming? These are questions which it would be useful to be able to answer with some greater approach to accuracy than at present. And it should be the work of definitely trained persons. I recall a sample of wood which some months ago, coming from a government department, went the round of the various institutions which were at all likely to be able to supply the required information as to its identity. It should have been matter of common knowledge where to apply, with at the same time reasonable certainty of obtaining the information required.

It is possible also that a more systematic study of minute structure would help to solve questions of affinity. A chemical study has proved of value in the discrimination of the species of *Eucalyptus* in Australia.

Apart from cooperation between the botanist and the practical or commercial man, there is need for coordination between workers. I give the following incident from real life. At the meeting of an advisory committee the head of a certain institution stated that he had set one of his staff to work at a certain disease which was then under discussion, but had learned shortly after that a student at another institution was engaged on the same piece of work. A conference led to a useful division, one of the workers to study the life history of the organism in the laboratory, the other to work at conditions of life, etc., in the field. But it also transpired that another institution, as well as another independent worker, was engaged on the same problem, and while it was suggested that in one case cooperation might be invited, it was deemed inadvisable to approach the other. The problem in this case was not one of such special difficulty as to require so much attention, and even if it had been some coordination between the various working units would have been helpful. Similar instances will occur to you. The measure of efficiency of our science should be the sum of the efficiency of its workers. It should

be possible to devise some means for informing fellow-workers as to the piece of work in hand or proposed to be undertaken, and thus, on the one hand, to avoid wasteful expenditure of time and effort, and not infrequently the hurried publication of incomplete results, and on the other, to ensure where practicable, the benefits of cooperation.

The various illustrative suggestions which I have made would imply a close cooperation between the schools of botany and colleges and institutions of agriculture, horticulture and forestry; to pass from the former to one or other of the latter for special work or training should be a natural thing. While, on the one hand, a university course is not an essential preliminary to the study of one or other of the applied branches, the advantage of a broad, general training in the principles of the science can not be gainsaid. The establishment of professorships, readerships or lectureships in economic botany at the university would supply a useful link between the pure and applied science, while research fellowships or scholarships would be an incentive to investigation.

There is the wider question of a rapprochement between the man of science and the commercial man. Its desirability is obvious, and the advantages would be mutual; on the one hand, it would secure the spread and application of the results of research, and on the other hand, the man of science would be directed to economic problems of which otherwise he might not become cognizant. The closer association between the academic institution and those devoted to the application of the science would be a step in this direction.

Our British possessions, especially within the tropics, contain a wealth of material of economic value which has been only partially explored. One of the first needs is a tabulation of the material. In the important series of Colonial floras incepted by Sir Joseph Hooker, and published under the auspices of Kew, lies the foundation for further work. Consider, for instance, the "Flora of Tropical Africa," now rapidly near completion. This is a careful and, so far as possible with the material at hand, critical descriptive catalogue of the plants from tropical Africa which are preserved in the great British and European herbaria. The work has been done by men with considerable training in systematic work, but who know nothing at first hand of the country, the vegetation of which they are cataloguing. Such a "Flora" must be regarded as a basis for further work. Its study will indicate botanical areas and their characteristics, and suggest what areas are likely to prove of greater or less economic value, and on what special lines. It will also indicate the lines on which areas may be mapped out for more detailed botanical exploration. That this is necessary is obvious to any botanist who has used such a work. A large proportion of the species, some of which may, on further investigation, prove to be of economic value, are known only from a single incomplete fragment. Others, for instance, which may be of known economic value, doubtless exist over much larger areas and in much greater quantity than would appear from the "Flora." The reason of these shortcomings is equally obvious. The collections on which the work is based are largely the result of voluntary effort employed more or less spasmodically. The explorer working out some new route, who brings what he can conveniently carry to illustrate the plant products of the new country; the government official or his wife, working during their brief leisure or collecting on the track between their different stations: the missionary or soldier, with a penchant for natural history; to these and similar persons we are largely in-

debted for additions to our knowledge of the plant-life. Advantage has sometimes been taken of a government expedition to which a medical man with a knowledge of or taste for natural history, or, in rare cases, a trained botanist, has been attached.

The specimens brought home by the amateur collector often leave much to be desired, and little or no information is given as to the precise locality or the nature of the locality, the habit of the plant, or other items of importance or interest. There may be indications that the plant is of economic value, but no information as to whether it is rare or plentiful, local or occurring over a wide area.

Samples of wood are often brought, but generally without any means of identification except a native name; and it must be borne in mind that native names are apt to be misleading; they may be invented on the spur of the moment to satisfy the white man's craving for information, or when genuine are often applied to more than one species.

A large proportion of the more extensive collections are due to German enterprise, and the best representation of this work is naturally to be found in Germany, though it is only fair to state that the German botanists have been generous in lending material for work or comparison. The botanical investigation of German East Africa and the Cameroons has been carried out by well-trained botanists and collectors, and the results of their work published both from botanical and economic points of view. I may refer to the large volume on German East Africa, which contains not only a general account of the vegetation and a systematic list of the genera and species comprising the flora, but also an account of the plants of economic value classified according to their uses. The exploration of the Belgian Congo has been seriously undertaken by the Belgian government, and a number of large and extensively illustrated botanical memoirs have been issued. Some of us may be familiar with the fine Congo Museum near Brussels.

It is time that pioneer work gave place to systematic botanical exploration of our tropical possessions and the preparation of handy working floras and economic handbooks. Work of botanical exploration should be full of interest to the young botanist. But if he is to make the best use of time and opportunity he must have had a proper course of training. After completing his general botanical course, which should naturally include an introduction to the principles of classification, he should work for a time in a large herbarium and thus acquire a knowledge of the details of systematic work and also of the general outlines of the flora of the area which he is to visit later. He should then be given a definite piece of work in the botanical survey of the area. From the collated results of such work convenient handbooks on the botanical resources of regions open to British enterprise could be compiled. There will be plenty of work for the systematist who can not leave home. The ultimate elaboration of the floristic work must be done in the herbarium with its associated library. There is also need of a careful monographic study of genera of economic value which would be best done by the experienced systematist at home, given a plentiful supply of carefully collected and annotated material. An example of such is the systematic account of the species of *Sanseviera* by Mr. N. E. Brown, recently issued at Kew. Closely allied, or varieties of one and the same, species may differ greatly in economic value, and the work of the monographer is to discover and diagnose these different forms and elucidate them for the benefit of the worker in the field.

If we are to make the best use of our resources, botanical research stations in dif-

ferent parts of the empire, adequately equipped and under the charge of a capable trained botanist, are a prime necessity. We seem to have been singularly unfortunate, not to say stupid, in the management of some of our tropical stations and botanical establishments.

The island of Jamaica is one of the oldest of our tropical possessions. It is easy of access, has a remarkably rich and varied flora, a fine climate and affords easy access to positions of widely differing altitude. It is interesting to imagine what Germany would have made of it as a station for botanical work if she had occupied it for a few years. The most recent account of the flora which pretends to completeness is by Hans Sloane, whose work antedates the Linnæan era. A flora as complete as available material will allow is now in course of preparation in this country, but the more recent material on which it is based is due to American effort. Comparatively recently a mycologist has been appointed, but there is no government botanist to initiate botanical exploration or experimental work or to advise on matters of botanical interest. A botanical station ideal for experimental work in tropical botanical problems is a mere appendage of a Department of Agriculture, the director of which is a chemist.

A botanical station for research to be effective must be under the supervision of a well-trained botanist with administrative capacity, who must have at his disposal a well-equipped laboratory and ground for experimental work. He must not be expected to make his station pay its way by selling produce or distributing seedlings and the like; a botanical station is not a market-garden. The director will be ready to give help and advice on questions of a botanical nature arising locally, and he will be on the lookout for local problems which may afford items of botanical research to visiting students. Means must be adopted to attract the research student, aided, if necessary, by research scholarships from home. The station should have sufficient imperial support to avoid the hampering of its utility by local prejudice or ignorance. The permanent staff should include a mycologist and a skilled gardener.

The botanical station does not preclude the separate existence of an agricultural station, but the scope of each must be clearly defined, and under normal conditions the two would be mutually helpful. Nor should the botanical station be responsible for work of forestry, though forestry may supply problems of interest and importance for its consideration.

Finally, I should like to suggest the holding of an imperial botanical congress at which matters of general and special interest might be discussed. The visit of the British Association to Australia was, I think, helpful to the Australian botanists; it was certainly very helpful and of the greatest interest to those coming from home. Many of the addresses and papers were of considerable interest and value, but of greater value was the opportunity of meeting with one's fellow-workers in different fields, of conversation, discussion and interchange of ideas, the better realization of one's limited outlook and the stimulus of new associations. A meeting which brought together home botanists and botanical representatives from oversea portions of our empire to discuss methods of better utilizing our vast resources would be of great interest and supremely helpful. Let us transfer to peace purposes some of the magnificent enthusiasm which has flowed homewards for the defence of the empire in war.

In this brief address I have tried, however imperfectly, to indicate some lines on which botanists may render useful service

to the community. To a large extent it means the further development and extension of existing facilities, added to an organized cooperation between botanists themselves and between botanists and the practical and commercial man: this will include an efficient, systematic cataloguing of work done and in progress. We do not propose to hand over all our best botanists to the applied branches and to starve pure research, but our aim should be to find a useful career for an increasing number of well-trained botanists and to ensure that our country and empire shall make the best use of the results of our research. Incidentally there will be an increased demand for the teaching botanist, for he will be responsible for laying the foundations.

Complaint has been made in the past that there were not enough openings for the trained botanist; but if the responsibilities and opportunities of the science are realized we may say, rather, "Truly the harvest is plentiful, but the laborers are few." Botany is the *alma mater* of the applied sciences, agriculture, horticulture, forestry, and others; but the *alma mater* who is to receive the due affection and respect of her offspring must realize and live up to her responsibilities.

A. B. Rendle

CHARLES SMITH PROSSER

The "country boys" of New York state never had a fair chance for a higher education until Cornell University was established with its state and government subsidies. The early days of that institution gave adequate proof of this and as the years have passed the successful careers of these boys of New York and Cornell have been eloquent testimony to this aid. True for many branches of human knowledge and practise, this statement is eminently applicable to the earlier graduates in the science of geology. Dr. Prosser, whose sudden and unexplained death on September 11 has been widely noticed in the press, was one of these country boys. Born in 1860 in Columbus, a little hamlet of Chenango County, N. Y., the son of a farmer of slight substance, and grandson of one of the early settlers of the region, the simple surroundings of his boyhood were of a kind to give unconscious direction to his maturing life. His home lay back on the hills which bound the Unadilla River on its way south to join the Susquehanna, and its outcropping rocks were filled with things which, to his attentive eye and naturally reflective mind, must have awakened many questionings. A farmer's boy in a stony country where fields have to be picked over regularly after the spring plowing, is pretty sure to either love or hate the rocks. A disposing mind led this farmer's boy to wish to know more about them. When the country school a few miles away at Brookfield could give him no more, he took the helping hand which Cornell held out and entered there in 1879. And it was to be his fortune in after life, when fully equipped, to return to his home valley and, under the auspices of his state geological survey, to apply his well-trained mind to the solution of its geological problems. So excellently did he habilitate himself in college that after his graduation as bachelor of science in 1883 he received the first award of the Cornell fellowship in natural history and then for three years was instructor in the department of geology. From there he went to Washington as an aid to the late Lester F. Ward, in the paleobotanical work of the U. S. Geological Survey. It was then I first came to know him while he was engaged in collecting fossil plants, and then, as always afterwards, I found him conscientious and earnest, though obviously not at that time particularly enthusiastic over the work that had been allotted to him. His experience as a teacher seemed to draw him toward that work again and he left Washington in 1894, though without dissolving his effective connection with the federal survey, to become professor of natural history in Washburn College, Topeka. There are active geologists to-day, who were his students there, but the major result of his stay in Kansas is, I

should say, the opening it afforded for his researches on the late paleozoic rocks of that state, problems that he followed not only while there, but to which he returned in later years. His work on the Carboniferous and Permian of Kansas and eastern Nebraska, some of it undertaken under the auspices of the Kansas University Geological Survey, was of unquestionably high value, much of it of fundamental importance. But it was his success as a teacher which gave him in 1894 a call to Union University at Schenectady, N. Y., and as it was a call which brought him back home and to the rocks of New York out of which he grew, he accepted it with alacrity. Union was then venturing on the experiment of establishing a separate department of geology, and her experiment was successful enough, as some admirable geologists and paleontologists and many other graduates of Union under Prosser's régime, stand to-day to testify. It was while at Schenectady that Professor Prosser entered upon his alliance with the New York Geological Survey and in this association accomplished a large amount of useful analytical work on its stratigraphical problems. His papers published during this period of his life were notable, and cover portions of eastern and central New York; the Mohawk Valley and the vicinity of Schenectady, the Helderberg Mountains, the Unadilla, the Oneonta, the Catskill and other regions—all characterized by his peculiarly exact and detailed procedure.

In his last year at Schenectady he was made chief of the Appalachian division of the Maryland geological survey and thereafter for several years his summers were spent in field work on the paleozoic rocks of Maryland, Pennsylvania and West Virginia.

In 1899 Professor Edward Orton, Sr., the distinguished state geologist of Ohio, former president of the State University, educated in Albany and in his later years allied with the official work of New York, perceiving the advance of the years, fastened on Prosser as the man to succeed him in the professorship of geology in the State University of Ohio at Columbus, and thither Dr. Prosser went as associate professor of historical geology. In 1901 he was made head of the department. There he remained till his death—seventeen years. Professor Orton died not long after Prosser's arrival in Columbus and I think the initiate was in some ways embarrassed by the sudden loss of the man who otherwise would have been his wise guide at the beginning of his new undertaking. For some time after settling in Columbus Dr. Prosser maintained his official and intimate relations with New York, but gradually the problems nearer to him invited his attention and a natural loyalty to the state of his adoption and his official connection with its survey, together with the requirements of his college work, absorbed his energies. In this period, however, he was able to give much time and to do much valuable work on the paleozoic rocks of Maryland under the auspices of the official survey of that state, now published as a part of the admirable series of reports of that organization. Of his many contributions to the geology of Ohio which have been published during his career at Columbus, most of them themes of stratigraphic determination and correlation, all bear the impress of his cautious mode and detailed analysis which make them practically final for the fields they cover.

It will be the work of another, I trust, to set forth adequately the merit of Dr. Prosser's many contributions to the science of geology, and to record the strong uplifting influence he had upon his pupils. There stand to his credit men of great worth in this science in American universities who were moulded by his hand, but for each one of these trained and proficient men there are scores who have felt the inspiration of his lectures, have been uplifted by his unstudied but unfailing courtesy and thoughtfulness and have been inspired by their association with him in the field. His courses at the Ohio State University had greatly grown in popularity and efficiency as his students were made to perceive the high cultural value of his science, wholly apart from any of its commercial phases.

But while I am not able fully to speak on this phase of his work except as I have learned

it from others, I desire to add a few words about the man as I have found him through the acquaintance of many years.

There never was a more loyal, a more devoted, a more sensitive spirit. His attitude of mind was puritanic in its simplicity and in its practises, and, left to himself, he could never suspect another of indirectness or duplicity—a quality of which he contained not a grain. When confronted by the broader bearings of his science and the natural sequences of its greater propositions, he held himself somewhat carefully aloof; it seemed as though the youthful bendings of the twig inclined him away from paths he would not follow. Yet this simplicity of heart, which would not let him go far a-field, also made him extraordinarily conscientious in his scientific work. It would not be fair to him to say that he had a genius for details, but it would be eminently right to assert that he sought intimately and faithfully for the exact construction of every observation he made so far as that had to do with the theme in hand. This mental method led him to precision of manner, gave him a certain formality which was seldom dismissed under the most informal circumstances. Dr. Prosser's physical address was very pleasing, but his natural reticence, his precision of thought and his fear of an inexact or loose statement made him a hesitant speaker, though a speaker who was always punctiliously guarding a jewel of highest worth—the truth. Added to this trait, which we may well count a virtue, was his absolute fealty to, first, his science, then to his friends. For those whom he knew to be his friends no sacrifice was too great, no defense too vigorous; from them no defection was thinkable. The word of personal criticism seldom passed his lips. If he had suffered an injustice, or an inadequate commentary, it was dismissed with a ripple of a deprecating smile, as though in pity of himself. His determinations of fact he was prepared to defend and to claim his title in them, and his high-strung temperament made him revolt when he saw the credit for his determinations complacently or in ignorance absorbed by another. To this he would not become inured, as almost every investigator in science must; it was to him a rape of his golden fleece.

Out of the quarry stones of his home land he had laboriously built the house of his desires; few know with what struggles against untoward circumstance, with what patient tugging at an unspoken load with which a churlish fate had saddled him. He did build the house of his spirit's desire and has left behind many who have seen far enough within its doors to honor his accomplishment, lament his sorrows and his unhappy end, and to cherish his memory.

Professor Prosser was buried in the Rural Cemetery at Albany where the members of the New York Geological Survey and representatives of Union University faculty and corporation gathered to pay their last respects to the poor suffocated body which had enshrined so pure a spirit.

JOHN M. CLARKE

THE NATIONAL RESEARCH COUNCIL

THE first meeting of the National Research Council was held in New York City on September 20, 1916. Dr. M. I. Pupin, as temporary chairman, called the meeting to order at 3.10 P.M., and directed a roll-call of the members of the council. There were present the following members: Messrs. Carty, Dunn, Goss, Hale, Herschel, Holmes, Keen, Manning, Marvin, Millikan, Noyes, Pickering, Pupin, Rand, Skinner, Squier, Stratton, Swasey and Vaughan.

The temporary chairman then called for nominations for permanent chairman. Dr. George E. Hale was nominated and unanimously elected. Dr. Hale then took the chair and presided for the remainder of the meeting. Dr. Charles D. Walcott was elected first vice-chairman, and Mr. Gano Dunn second vice-chairman.

Dr. Hale, as chairman of the organizing committee of the council, first announced an agreement between the National Academy of Sciences and the Engineering Foundation by which the foundation has placed its funds at the disposal of the council for a period of one

year and has given the services of its secretary, Dr. Cary T. Hutchinson, to the National Research Council, to serve as its secretary. Dr. Hale announced that in accordance with this agreement the National Academy of Sciences has appointed Dr. Hutchinson, secretary of the National Research Council. Dr. Hutchinson was present and acted as secretary to the meeting.

The chairman then gave an extended account of the work done by the organizing committee during the summer months, dwelling particularly upon his trip to England and France, and upon the results that have been reached there by similar organizations of the men of science.

At the conclusion of the chairman's remarks the organization of the council was discussed; and the motion was made that an executive committee, to consist of a chairman and nine members, be appointed by the chair, with the chairman of the council and president of the academy as additional members ex-officiis, this committee to have full authority in the interim between meetings of the council to carry out the purposes described in the preliminary report of the organizing committee (published in the August 25 number of SCIENCE), it being understood that, in carrying out the general plan of work of the council as there outlined, the executive committee shall not be limited to a narrow interpretation of the objects, but shall have full power to undertake similar or related work, even though not specifically included in that report. This motion was carried unanimously.

The chairman then requested the members of the council to express their views on the proposed work of the council and in particular to make suggestions covering definite lines of work that might fall within the sphere of activity of the council. A discussion then took place, participated in by nearly all the members of the council.

Dr. Millikan then presented a preliminary report from the committee on the Newlands Bill, which provides for the appropriation by the government of $15,000 annually to each of the states, to be applied to research in engineering and applied science. After discussion the report was referred back to the committee for further consideration, with instructions that it be then referred to the executive committee of the Research Council.

A recess was then taken to enable the members of the council to attend a dinner given in their honor at the University Club by Dr. Hale. The council was again called to order at 9.30 P.M. by the chairman. The members present then discussed special features of the work that the council might undertake.

The chairman announced the appointment of the following six members of the executive committee: Messrs. J. J. Carty, E. G. Conklin, Gano Dunn, A. A. Noyes, M. I. Pupin and V. C. Vaughan. He stated that the other four members would be appointed after further consideration. A vote of thanks to the chairman for his invaluable services was unanimously adopted. After further general discussion the council adjourned.

Two meetings of the executive committee were held in New York on September 21 and 29, 1916. At these meetings business was transacted as follows:

Dr. J. J. Carty was elected chairman; and Dr. C. T. Hutchinson, secretary of the committee. It was voted that the terms of the present members of the research council and of the executive committee be deemed to expire on January 1, 1918.

The following resolution was adopted, expressing the general policy to be followed by the council in the promotion of research.

Resolved, that the efforts of the Research Council shall be uniformly directed to the encouragement of individual initiative in research work, and that cooperation and organization, as understood by the Research Council, shall not be deemed to involve restrictions or limitations of any kind to be placed upon research workers.

The following resolution was adopted, inviting the American Association for the Advancement of Science to cooperate with the Research Council.

Resolved, that the American Association for the Advancement of Science be informed that the National Research Council has been organized by the National Academy of Sciences at the request of

the President of the United States for the purpose of bringing into cooperation existing governmental, educational, industrial and other research organizations, with the object of encouraging the investigation of natural phenomena, the increased use of scientific research in the development of American industries, the employment of scientific methods in strengthening the national defense, and such other applications of science as will promote the national security and welfare, and that the association, which has itself established the Committee of One Hundred on Research, be invited to cooperate with the Research Council in the promotion of research, and that to this end it be asked to appoint a committee of three to meet with a similar committee of the Research Council to consider how much cooperation can be made most effective.

As members of this committee on behalf of the Research Council, Dr. Welch, president of the Academy, and Messrs. Conklin and Noyes were appointed.

The following committees were also appointed:

A Committee on Research in Educational Institutions, consisting of G. E. Hale, chairman, J. S. Ames, R. H. Chittenden, J. M. Coulter, G. N. Lewis, G. H. Parker, Harold Penders, C. R. Van Hise and F. J. E. Woodbridge; this committee to consider general plans for the promotion of research in educational institutions, and to have power to arrange for local research committees in each institution.

A Committee on the Promotion of Industrial Research, Dr. J. J. Carty, chairman, with functions in its field somewhat similar to those of the Committee on Research in Educational Institutions.

A Committee on a National Census of Research, Dr. Stratton, chairman, to prepare a national census of equipment for research, of the men engaged in it, and of the lines of investigation pursued in cooperating government bureaus, educational institutions, research foundations and industrial research laboratories.

Mr. Dunn reported that the United Engineering Society had granted for a period of one year from October 1, 1916, free of assessment, two rooms in its building for the use of the Engineering Foundation, to serve as the New York Office of the National Research Council, these rooms being those recently vacated by the Naval Consulting Board.

It was voted to recommend to the president of the academy that Marston T. Bogert, of Columbia University, Russell H. Chittenden, of Yale University, and Raymond Pearl, of the Maine Experiment Station, be invited to become members of the council.

It was voted that joint committees on research in various branches of science be formed in cooperation with the corresponding national scientific societies.

A more complete account of the actions and discussions of the Research Council and of its executive committee will be found in the October number of the *Proceedings* of the National Academy of Sciences.

CARY T. HUTCHINSON,
Secretary

ORGANIZATION OF THE NATIONAL RESEARCH COUNCIL

THE National Research Council was formally organized at a meeting held in New York City on September 20, 1916. It was established by the National Academy of Sciences at the request of the President of the United States. The members of this council have been appointed by the president of the academy, after consultation with the presidents of leading national scientific societies. The representatives of the government were appointed by the President of the United States. The council is to be gradually enlarged by the addition of new members who are to serve as chairman of important committees or who are otherwise to engage in some special capacity in the work of the council.

The organization of the council is at present as follows:

OFFICERS AND EXECUTIVE COMMITTEE

Chairman, George E. Hale.
Vice-chairmen, Charles D. Walcott; Gano Dunn.
Secretary, Cary T. Hutchinson.
Executive Committee, John J. Carty (chairman), William H. Welch (ex-officio), George E. Hale (ex-officio), Edwin G. Conklin, Gano Dunn, Arthur A.

Noyes, Raymond Pearl, Michael I. Pupin, S. W. Stratton, V. C. Vaughan, and others to be appointed.

MEMBERS

Dr. L. H. Baekeland, Yonkers, N. Y.

Dr. Marston T. Bogert, professor of organic chemistry, Columbia University.

Dr. John A. Brashear, Allegheny, Pa.

Dr. John J. Carty, chief engineer, American Telephone & Telegraph Co.

Dr. Russell H. Chittenden, director, Sheffield Scientific School, Yale University.

Dr. Edwin G. Conklin, professor of zoology, Princeton University.

Dr. John M. Coulter, professor of botany, University of Chicago.

Major General William Crozier, chief of ordnance, U. S. A.

Mr. Gano Dunn, president, The J. G. White Engineering Corporation.

Dr. Simon Flexner, director, Rockefeller Institute for Medical Research.

Brigadier General William Crawford Gorgas, surgeon general, U. S. A.

Dr. W. F. M. Goss, dean of engineering, University of Illinois.

Dr. George E. Hale, director, Mt. Wilson Solar Observatory.

Mr. Clemens Herschel, president, American Society of Civil Engineers.

Dr. William H. Holmes, curator, United States National Museum.

Dr. W. W. Keen, president, American Philosophical Society.

Mr. Van H. Manning, director, Bureau of Mines.

Professor Charles F. Marvin, chief, United States Weather Bureau.

Professor A. A. Michelson, director, Ryerson Physical Laboratory, University of Chicago.

Dr. Robert A. Millikan, professor of physics, University of Chicago.

Dr. Arthur A. Noyes, director, research laboratory of physical chemistry, Massachusetts Institute of Technology.

Dr. Raymond Pearl, director, Maine Agricultural Experiment Station.

Professor E. C. Pickering, director, Harvard College Observatory.

Dr. Michael I. Pupin, professor of electro-mechanics, Columbia University.

Mr. Charles F. Rand, president, United Engineering Society.

Dr. Theodore W. Richards, director, Walcott Gibbs Memorial Laboratory, Harvard University.

Mr. C. E. Skinner, director, research laboratory, Westinghouse Electric & Manufacturing Co.

Lieutenant Colonel George O. Squier, chief of aviation, U. S. A.

Dr. S. W. Stratton, director, Bureau of Standards.

Mr. Ambrose Swasey, Cleveland, Ohio.

Chief Constructor David W. Taylor, U. S. Navy.

Dr. Elihu Thomson, Swampscott, Mass.

Dr. C. R. Van Hise, president, American Association for the Advancement of Science.

Dr. Victor C. Vaughan, director, medical research laboratory, University of Michigan.

Dr. Charles D. Walcott, secretary, Smithsonian Institution.

Dr. William H. Welch, president, National Academy of Sciences.

Dr. W. R. Whitney, director, research laboratory, General Electric Co.

SCIENTIFIC NOTES AND NEWS

On the occasion of the celebration of the 150th anniversary of Rutgers College the degree of doctor of science was conferred on Dr. J. L. R. Morgan, of the class of '92, professor of physical chemistry in Columbia University; on Dr. Peter Cooper Hewitt, of New York City, and on Chuzaburo Shiba, professor of mechanical engineering in the Imperial University of Tokyo.

The Italian Society of Sciences has awarded its gold medal for 1915 to Professor P. Calapso, of the University of Messina, for his researches in geometry.

Edward Ray Weidlein has been appointed associate director of the Mellon Institute of Industrial Research of the University of Pittsburgh. Mr. Weidlein has held an industrial fellowship since 1910, and during the past four years has been in active charge of the hydrometallurgical investigations of the institute.

Mr. Victor A. Beede, assistant state forester of New Hampshire, has been elected executive secretary of the New York State Forestry Association, with headquarters at the Chamber of Commerce Building, Syracuse, N. Y.

At its meeting held on October 11, the Rumford Committee of the American Academy of Arts and Sciences appropriated the sum of $300 to Professor J. A. Parkhurst, of the Yerkes Observatory, in aid of his investigation on the determination of the photovisual scale of stellar magnitudes.

We learn from the *Journal* of the American Medical Association that the governor of Minnesota has appointed a commission composed of the following members to investigate and report on the need of additional health safeguards for the citizens of the state: Dr. E. P. Lyon, dean of the University of Minnesota Medical School, Minneapolis; C. G. Schultz, superintendent of the state department of education; William F. Houk, state labor commissioner; C. J. Swendsen, chairman, state board of control; Senator L. E. Potter, Springfield; Drs. Arthur T. Laird, superintendent of the Nopeming Sanatorium; Louis B. Wilson, Rochester; Warren L. Beebe, president, and Ignatius J. Murphy, St. Paul, executive secretary of the Minnesota Public Health Association. At the meeting for organization, held September 20, in St. Paul, Dr. E. P. Lyon was elected chairman, and Dr. Ignatius J. Murphy, secretary of the commission.

The motion picture film, "How Life Begins," was presented on October 6, before the New York Association of Biology Teachers. This picture has been perfected by George E. Stone, A.B., of Berkeley, Cal., in collaboration with Dr. J. A. Long, assistant professor of embryology of the University of California. It embodies many interesting features in the life-history of the different classes of animals.

At its regular fall meeting on September 27, the Elisha Mitchell Scientific Society elected the following officers for the coming year: *President*, T. F. Hickerson; *vice-president*, J. G. Beard; recording-secretary, J. W. Lasley, Jr. The following were elected to associate membership in the society: R. P. Brooks, J. W. Hale, J. W. Scott, C. W. Higgins, A. C. Forney, W. T. Harper, Geo. Slover, M. M. Williams, and S. H. Hobbs, Jr. At the first meeting for discussion, on October 10, two papers were presented to the society by Dr. A. S. Wheeler on "The Second International Chemical Exposition," and by J. W. Lasley, Jr., on "Some Elementary Vector Equations."

The Cartwright lectures of the Association of the Alumni of the College of Physicians and Surgeons, Columbia University, will be given on October 24 and 25, at 5 o'clock, by Dr. Richard M. Pearce, Jr., professor of research medicine of the John Herr Musser Department of Research Medicine, University of Pennsylvania. His subject will be "The Spleen in Its Relation to Blood Destruction and Regeneration."

The twelfth course of Harvey Society lectures will begin on October 14 and close on April 7. The lectures will be given on Saturday evenings in the New York Academy of Medicine. The following lectures are announced: October 14—Professor J. S. Haldane, "The New Physiology"; November 4—Dr. F. M. Allen, "The Rôle of Fat in Diabetes"; November 25—Dr. Paul A. Lewis, "Chemo-Therapy in Tuberculosis"; December 16—Professor Henry H. Donaldson, "Growth Changes in the Mammalian Nervous System"; January 13—Professor E. V. McCollum, "The Supplementary Dietary Relationships Among Our Natural Foodstuffs"; February 3—Professor J. W. Jobling, "The Influence of Non-Specific Substances on Infections"; February 24—Professor John R. Murlin, "The Metabolism of Mother and Offspring before and after Parturition"; March 17—Professor Francis W. Peabody, "Cardiac Dyspnea"; April 7—Professor W. H. Howell, "The Coagulation of the Blood."

Professor J. Norman Collie, director of the chemical laboratories of University College, London, gave a lecture on October 31, on "The Scientific Work of Sir William Ramsay."

October 11 was observed by the Chicago Medical Society as Dr. John B. Murphy me-

morial night. The following were announced as speakers: Drs. George W. Crile, Cleveland; C. A. L. Reed, Cincinnati; Frank Billings, L. L. McArthur, E. Wyllys Andrews, D. A. K. Steele, A. D. Bevan, W. E. Quine, A. J. Ochsner, Jacob Frank and W. A. Evans.

A bronze bust of Dr. Nicholas Senn has been presented to the Wisconsin Historical Museum, Madison, by Dr. Emanuel J. Senn, of Chicago. Dr. Senn began his practise as a country practitioner near Fond du Lac in 1869.

Dr. Levi Leonard Conant, head of the department of mathematics at the Worcester Polytechnic Institute, was killed by an automobile truck on October 11. Professor Conant was born in 1857. He was known for his work on primitive number concepts, the history of mathematical notation and the theory of functions and of graphs.

Don José Echegaray, professor of mathematical physics in the University of Madrid, and distinguished also as a poet and dramatic author, died on September 15, aged eighty-three years.

Dr. V. von Czerny, professor of surgery at the University of Heidelberg since 1877 and chief of the cancer research hospital there, has died, aged seventy-four years.

The death is also announced of A. Magnan, one of the leading alienists of France.

Mr. R. J. L. Guppy, known for his work on the geology of Trinidad and other West Indian Islands, his died at the age of eighty years.

The death in Munich, on June 22, of Mr. Gustav Mann, is announced in *Nature*. Mr. Mann, who was in his eighty-first year, was known for his botanical work in Africa and India.

Mr. E. G. Kensit, a member of the Botanical Department of the South African College, has been killed in the war.

The *Auk* for October contains obituary notices of several ornithologists, John Alexander Harvie-Brown, D.D., died at his residence, Dunipace House, Stirlingshire, Scotland, July 26, 1916. He was born at Dunipace, August 27, 1844, and spent his life there, being a landed proprietor who devoted himself to natural history. He was best known for his work in connection with the "Vertebrate Fauna of Scotland," of which he was chief editor and author of many of the volumes. He was also the founder, owner and joint editor of the "Annals of Scottish Natural History," as well as a supporter of its successor, "The Scottish Naturalist." Col. Herbert Hastings Harrington, the British ornithologist, noted for his work on the "Birds of Burma" (1909) and for numerous papers on Indian birds, was killed in the campaign in Mesopotamia on March 8, 1916. He was born on January 16, 1868, at Lucknow. Lieutenant-Colonel Boyd Robert Horsbrugh, well known as the author of "The Game Birds and Water-Fowl of South Africa" and of numerous articles in *The Avicultural Magazine* died at his home in Surrey, England, on July 11, having been invalided home from France in 1915. Colonel Horsbrugh was born at Poona on July 27, 1871. John Claire Wood, known in Michigan as an oologist and ornithologist, died June 16, 1916, at his home in Detroit, aged forty-five years.

UNIVERSITY AND EDUCATIONAL NEWS

Pledges have been received for the full amount of the Vassar College million dollar endowment fund. $200,000 had been pledged by the General Education Board of the Rockefeller Foundation on condition that the balance be raised. The fund will be used for the endowment and equipment of the college.

The merger of the medical department of the University of Pennsylvania and the Jefferson Medical College has been postponed for a year, and it is thought that the union may be abandoned.

The new chemistry building of the Throop College of Technology which with its equipment will cost nearly $100,000 is approaching

completion and will be ready for occupancy about December 1, when Dr. Arthur A. Noyes will go to Pasadena, where from now on he will spend half of each year. James H. Ellis, Ph.D. (Mass. Inst.) has been appointed research associate in physical chemistry in the college.

THE appointments of Drs. Edward H. Nichols and Charles A. Porter as clinical professors in the Harvard Medical School have been confirmed by the university's board of overseers. Both men formerly held positions as associate professors.

HAROLD VEATCH BOZELL has been appointed assistant professor of electrical engineering in the Sheffield Scientific School of Yale University for the college year 1916–17, for which period he has secured leave of absence from the University of Oklahoma, where he is dean of the school of electrical engineering and professor of electrical engineering.

PROFESSOR C. N. HASKINS, of Dartmouth College, has been promoted to a full professorship of mathematics. Drs. R. D. Beetle and F. M. Morgan have been promoted to assistant professorships of mathematics.

ROY G. HOSKINS, associate professor of physiology in the Northwestern University Medical School, has been promoted to be full professor and head of the department. Virgil Ernest Dudman, M.D., interne in Cook County Hospital, Chicago, has been elected assistant professor of hygiene and director of student health.

H. H. BUNZELL, Bureau of Plant Industry, has been appointed assistant professor of biochemistry at the University of Cincinnati Medical School.

DR. A. A. BENNETT, of Princeton University, has been appointed adjunct professor of mathematics at the University of Texas.

O. F. BURGER has been appointed instructor in plant pathology in the Graduate School of Tropical Agriculture of the University of California at Riverside, and Alfred Free Swain, formerly of Montana State College and of Stanford University, assistant in entomology there.

DISCUSSION AND CORRESPONDENCE

COLLOIDS AND NEGATIVE SURFACE TENSION

IN a review of Professor Fischer's translation of Wo. Ostwald's "Handbook of Colloidal Chemistry" which recently appeared in this journal,[1] Professor W. A. Patrick states that the existence of negative surface tension which is assumed by Ostwald is contrary both to experimental evidence and to the fundamental ideas of surface tension. Although the present writer does not agree with all of Ostwald's energetic considerations, he wishes to point out that the existence of negative surface tension under certain circumstances is not only supported by a vast body of experimental evidence but is necessitated by the thermodynamic theory of the stability of colloidal solutions.

Surface tension may be defined in the usual way as the work which has to be done in order to increase the surface in question by one square centimeter, this increase in surface being carried out of course reversibly and isothermally. This work, however, and hence also the surface tension, may be either positive or negative.

If for a given two-phase system the surface tension at the boundary between phases is positive, then a positive quantity of work will have to be done in order to increase this surface, and such an increase in surface will be accompanied by an increase in the free energy of the system. Since all spontaneous changes in a system must be in the direction of decrease of free energy, these systems with positive surface tension if left to themselves will automatically decrease the surface between phases. Thus, for example, in the case of finely divided crystals of copper sulfate in contact with a saturated solution, we have a system in which there is positive surface tension at the boundary between the phases, and if this system is left to itself there will be a spontaneous decrease in surface, the smaller crystals going into solution and precipitating on the larger until finally we have all the solid copper sulfate in one large crystal, this being the condition of smallest possible surface.

If, on the other hand, we have a two-phase

[1] SCIENCE, 43, 747, 1916.

system with negative surface tension at the boundary between phases, instead of it requiring work to increase the surface, the system could actually be made to do external work on its surroundings when an increase in surface takes place. In such systems there will obviously be a *decrease* in free energy accompanying increase in surface and if left to themselves these systems will spontaneously increase their surface either by an increase in the convolutions of the boundary or by dispersion into smaller particles. Since spontaneous changes can only take place when accompanied by decrease in free energy it is evident then that *we have negative surface in the case of all systems which are undergoing a spontaneous increase in surface.*

There are of course, as a matter of fact, an enormous number of systems which undergo spontaneous increase in surface, and hence possess negative surface tension. All of the hydrophyllic colloidal substances, such as gelatine, agar-agar, lecithin, etc., will spontaneously disperse when placed in contact with water and hence have negative surface tension. (When lecithin is placed in contact with water the formation of protuberances and consequent increase in surface can be observed under the microscope.) Also in the case of hydrophobic colloidal systems it is well known that under proper conditions an increase in the degree of dispersion will take place; thus colloidal solutions of ferric hydroxide increase their dispersion when hydrogen ion is added to the solution, flocculent gold can be dispersed with ammonia,[2] ferric hydroxide which has been precipitated with sodium chloride is redispersed when the chloride is washed out,[3] and, as shown by Mr. R. J. McKay working in the writer's laboratory, the size of the particles in a colloidal solution of carbon (Higgin's drawing ink) depends on the concentration of added sodium chloride, and particles whose size has been increased by addition of sodium chloride grow gradually smaller again on dialysis with pure water. Hence in all these cases we have experimental evidence of negative surface tension.

From the foregoing considerations we see that there is positive surface tension in the case of all colloidal solutions in which the size of the dispersoid particles is automatically increasing, and negative surface tension in case the size of the particles is decreasing, and that for stable colloidal solutions the surface tension at the boundary between dispersing medium and dispersoid will be zero. Furthermore, since in cases where automatic dispersion is taking place, this continues only until a definite size of particle is reached, we are led to the conclusion that surface tension is in general a function of the size of the particles. A stable colloidal solution is thus one in which the particles have that particular size which has zero surface tension.

Such ideas as to positive, negative and zero surface tension, and as to the relation between surface tension and size have already appeared in the literature. The possibility of explaining automatic colloidal solution and the permanent colloidal state by assuming a negative surface tension between phases which becomes zero at a definite degree of dispersion was first outlined by Donnan,[4] on the basis of a suggestion of Van'T Hoff; has also been expressed by Perrin,[5] and has been definitely adopted by the present writer on thermodynamic grounds in a presentation of a somewhat complete thermodynamic theory of equilibria of dispersed systems in general and of colloids in particular.[6]

[2] Whitney and Blake, *J. Amer. Chem. Soc.*, 26, 1,341, 1904.

[3] Linder and Picton, *J. Chem. Soc.*, 87, 1,924, 1905.

[4] Donnan, *Z. physik. Chem.*, 37, 735, 1901; 46, 197, 1903. It is possible that Donnan has since abandoned this theory as a satisfactory explanation of the colloidal state. See Ellis, *Z. physik. Chem.*, 80, 611, 1912.

[5] Perrin, *J. chim. phys.*, 3, 92, 1904. "Il me semble donc que l'existence même d'un hydrosol force à regarder la tension superficielle comme étant un fonction du diamètre du granule, fonction qui, nulle pour un certain diamètre, est positive pour un diamètre inférieur, et negative pour un diamètre supérieur." In a later paragraph (*loc. cit.*, p. 94) Perrin somewhat modifies this point of view that the surface tension is exactly zero at the degree of dispersion which is stable.

[6] *J. Am. Chem. Soc.*, 35, 317, 1913.

It has there been shown that such ideas can be successfully employed for the general treatment of the phenomena of lyophobic and lyophyllic colloids. In the case of lyophyllic colloids it is pointed out that in general the surface tension for undispersed dispersoid is negative and hence automatic dispersion takes place until the size of particles is reached which have zero surface tension. While for lyophobic colloids large particles have positive surface tension, and this only becomes zero for very small particles. This necessitates a preliminary dispersion by electrical, mechanical or chemical means for the artificial preparation of lyophobic colloidal solutions which unlike lyophyllic colloidal solutions are of infrequent occurrence in nature. The writer has also discussed there the rôle of the electrical charge always present on lyophobic colloidal particles in producing the state of zero surface tension necessary for permanent stability.[7]

Freundlich[8] is perhaps the principal exponent of a theory of colloidal solution which does not take zero surface tension as the necessary accompaniment of the stable colloidal state. According to this theory the surface tension at the boundary of the dispersoid particles is always positive and hence there is always a tendency for the particles to unite with decrease of surface. The electrical charges on the particles, however, by mutual repulsion prevent such a union and keep the system in a permanent, although thermodynamically unstable state. Although the writer would not deny that there may be some colloidal solutions which may be in a relatively permanent state without having really reached a condition of minimum of free energy, he believes, however, that the Freundlich theory is entirely inadequate for a general treatment of colloidal phenomena. Not only does the absolutely permanent stability of colloidal solutions point to true thermodynamic equilibrium, but the actual growth of particles to a new equilibrium size on small additions of electrolytes to colloidal solutions and their redispersion to the old size on washing out the electrolyte could only be the case if we have a real thermodynamic equilibrium. Furthermore, Freundlich's assumption that an actual collision and union of particles is necessary for a decrease in degree of dispersion seems to be entirely unjustified since with positive surface tension, as is well known, the material in the smaller particles would have a higher solubility than that in the larger particles, and the latter would grow at the expense of the former. Indeed, the *continuous* growth of particles from one equilibrium size to another is evidence that some other process than that of simple union is taking place. Finally, the existence of a *definite equilibrium size* of particle contradicts his theory since if the stability were due merely to an electrical repulsion that kept particles apart this would work equally well with particles of all sizes, while microscopic examination shows that in typical lyophobic colloidal solutions all the particles have the same size except for a few very large ones which are floating around with the others and are apparently so large that they lie in the region of positive surface tension which, as we have already seen, characterizes *undispersed* lyophobic dispersoid.[9]

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[7] If we wish to extend our considerations to the case of particles so small that they contain only a few ultimate molecules, it may seem somewhat misleading to speak of a definite value of the surface tension, and in that case it may seem more desirable to relate the free energy of the dispersoid directly to the degree of dispersion, without intermediate considerations as to surface tension. This, however, involves no change in principle in our method of attack.

[8] Freundlich, "Kapillarchemie," 1909.

[9] There are of course in all probability some lyophobic dispersoids in which the surface tension is nearly zero for particles having a considerable range of size, and in such cases even in a stable solution there will be considerable variation around the equilibrium size of particle. Indeed, in colloidal solutions in equilibrium, we shall expect in general a distribution in the size of the particles according to the laws of probability around that size which has exactly zero surface tension, and the more rapid the change of surface tension with dimensions the more nearly will all the particles be of the same size.

THE AURORAL DISPLAY OF AUGUST 26

It may interest the readers of Science to know that the "remarkable auroral display" described by Professor Nutting in Science of October 6, was visible also in the eastern states. I watched it for many hours at my cottage on Chebeague Island, Maine; and others, who watched it there, declare that it lasted until well after midnight.

The display was of so unusual a character that I could not believe it to be the "northern lights." As Professor Nutting says, its greatest intensity and brilliancy was in the zenith, and to us the light seemed to radiate and pulsate from *east* to *west*. This fact led me to call the display the zodiacal light, which I had never seen, and about which I knew only the name. I should be glad to know if the phenomenon was, without question, an aurora borealis.

L. M. Passano

Massachusetts Institute of Technology

I was much interested to read Professor Nutting's description of the remarkable auroral display of August 26. I observed the same phenomenon at Annisquam, Essex County, Mass., which Professor Nutting so well described. Auroras were of quite common occurrence this summer at Annisquam, I having noted them on the evenings of June 22, 29, 30, August 26, 27, 28, and September 2, 9 and 11, but the display of August 26 far surpassed any aurora I had ever seen. The Boston papers of August 27 made a note of the aurora and stated that the telegraph and telephone lines in eastern Massachusetts had been greatly disabled and in some cases put out of commission during the previous evening. It would be interesting to know if wireless telegraph operators noticed any unusual occurrence of "static" at that time.

Barry MacNutt

Lehigh University

The remarkable auroral display described by Professor Nutting in a recent number of Science was also observed on the same date, August 26, at Rochester, N. Y., from the Cobb's Hill reservoir. A member of my family called our attention to what appeared to be vivid flashes of sheet lightning. Close observation, however, showed that the apparent electrical display was really an exhibition of the great northern lights or aurora borealis. As described by Professor Nutting, the lights flickered, streamed in great sheets, danced in long shafts, and shimmered in vast expanses of rapidly changing light.

The light was strongest and most remarkable at the zenith where the play was the most intense. The quickly changing forms of the display followed each other with marvelous rapidity as noted by Professor Nutting. In Rochester the light resembled electricity, the colors of the northern Michigan display being absent or but feebly visible, owing probably to the greater distance south of the observing locality. The display was first seen about eight o'clock in the evening and was under observation until after ten o'clock. How much longer the display lasted I am unable to state. It would be of interest to know in what other places far removed from Michigan this auroral display was observed.

Frank C. Baker

The New York State College of Forestry, Syracuse University

C. C. Nutting has accurately described the aurora borealis which spanned the northern heavens up to the zenith on the evening of August 26, 1916, at Lake Douglas in northern Michigan. Identically the same aurora was seen by me on the same evening between the hours of nine and ten, at Oak Bluffs, on the eastern shore of Martha's Vineyard, Mass., but somewhat dimmer, owing perhaps to my station on the seashore. The pulsations of light in the form of huge bands changing constantly in intensity and position, as well as the formation of the streamers which he has described, were marked features of the phenomenon.

John W. Harshberger

University of Pennsylvania

In the current issue of Science, Professor Nutting describes an aurora seen by him on the evening of August 26, remarkable for the large expanse of the heavens which it occupied. It may be of interest to know that the same display was visible a thousand miles east of

where Professor Nutting saw it. I observed the same thing on that evening at Starr's Point, near Wolfville, Nova Scotia. The same great extent of the display was evident, but the brightness was not equal to that described by Professor Nutting. At intervals the display would vanish, to reappear shortly in as great an extent as before. The focus of the aurora seemed to be near the zenith as Professor Nutting describes it.

The aurora was noticed as soon as it was dark, which in that latitude and at that time was about eight P.M., and lasted for two hours at least; how much longer I am unable to say. The color was uniformly a pearly white; no trace of any other tint appeared.

PAUL R. HEYL

PHILADELPHIA, PA.

THE SCIENTIFIC APPOINTMENTS OF PRESIDENT WILSON

TO THE EDITOR OF SCIENCE: In the published discussions of the wisdom of the president's appointments in the so-called scientific bureaus of the government and especially in those regarding his recent choice of a superintendent for the Coast and Geodetic Survey I have seen no reference to one phase of the subject that seems to me to be, at the present time, of the utmost importance.

Great emphasis is now placed by the president and his cabinet on the necessity for "mobilizing" all of the resources of the country, both material and human, so that these resources shall be instantly and completely available for the defense of the country in case such defense shall be called for and extraordinary measures are being resorted to for that purpose.

Those familiar with the work and history of the service will be inclined to think that in the event of an attack by any great power possessed of a strong navy (we are in little danger from any other) the success of our defense will depend in large measure upon the efficiency of the small corps of men constituting the United States Coast and Geodetic Survey. These men have an intimate knowledge of our coast in all its vast extent, of all the avenues of approach, of obstacles that exist and where such may be easily created, and of the topography of a wide strip of land bordering on the sea, possessed by no other body, and in time of war involving naval attack and attempted landing of troops their knowledge will be invaluable. This fact was fully recognized during the civil war of half a century ago and almost from the beginning the regular operations of the survey were suspended that its officers might be detailed to various military operations on the coast. The superintendent himself personally undertook preparations for the defense of the city of Philadelphia.

Military and naval officers everywhere gave unstinted praise to the work of the officers of the Coast Survey, declaring in many instances that without their cooperation important military operations would have been impossible. Under the conditions of modern warfare, when fighting is directed by maps and charts, the enemy being often so far away as to be quite invisible, it is clear that such services as the Coast Survey can render will be immensely more important than they were during the civil war. Indeed it is no exaggeration to say that this small but unique group of highly trained experts under proper leadership should be worth more than half a dozen superdreadnaughts. One may be rash to compare their possible usefulness with that of the recently organized and mobilized aggregation of assorted geniuses from which the president and the country at large are expecting so much, but some knowledge of the work of the officers of the survey during the civil war and a study of the newly developed methods of warfare may justify or excuse such rashness. These facts alone, without considering others, some of which were presented by Dr. Evermann in a recent number of SCIENCE, seem sufficient to account for the surprise and disappointment that were almost universal among those having knowledge of the situation when the president selected as the head of this, the oldest and one of the most important of the scientific bureaus of the government, not one of a considerable number of men who by reason of their reputation and accomplishments are

eminently fitted for the important office, but one who, though personally quite irreproachable, was totally ignorant of the operations of the great organization which he was called upon to direct and whose previous training and experience are such as to leave little hope that he will ever be able to acquire more than a very superficial knowledge of these operations.

The incident, with others of a similar character recently brought into public notice, serves to illustrate the folly of making appointments to places in the government demanding special qualifications for either personal or political reasons. Happily the practise is becoming more infrequent as administrations come and go and the more the people realize its costly and disastrous consequences the sooner it will disappear entirely.

R.

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING

In view of the critical importance of the issues pending before the Carnegie Foundation for the Advancement of Teaching, it is important that a general expression of views by college and university professors be available. The issues relate to the privileges of retirement and the proposed provisions for insurance and annuities which the foundation has offered in their place. The report of the Committee on Pensions of the American Association of University Professors will soon be available. A group of influential universities have published replies to the proposals of the foundation. The undersigned has published in *School and Society* (October 7, 1916) a general review of the ten years of activity of the foundation with special reference to the pending issues. These several expressions indicate a general and emphatic opposition to the steps proposed by the foundation; they enter into detailed consideration of the grounds upon which such opposition is based. Upon the basis of these documents individual opinions are desired indicating how far and in what respects the contentions are approved. Statements of general approval and disapproval as well as of specific positions approved or disapproved will be helpful in reaching a fair indication of the judgment of those interested. Communications should be made promptly.

Joseph Jastrow

Madison, Wis.

QUOTATIONS

THE BRITISH COMMITTEE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

The report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1915–16 has recently been issued. The sum at its disposal for the financial year 1915–16 was £25,000, out of which £4,250 was granted to the Royal Society. For the current financial year 1916–17 the vote was £40,000, and at the close of the academic year a sum not exceeding £6,000 will have been granted to a number of individual research workers, students and others. In an appendix is the first annual report of the advisory council. It consists of Sir William S. McCormick (chairman), Lord Rayleigh, Sir George T. Beilby, Mr. W. Duddell, Professor J. A. McClelland, the Hon. Sir Charles A. Parsons, Professor J. F. Thorpe and Mr. Richard Threlfall. There are three standing committees—on engineering, metallurgy, and mining, respectively. A sketch is given of government action in the present century previous to May, 1915, when the presidents of the boards of trade and education received a deputation from the royal and other learned societies, urging the need for government assistance for scientific research for industrial purposes, and the establishment of closer relations between the manufacturers and scientific workers and teachers. The government scheme was issued a couple of months later, and the special committee of the privy council and the advisory council itself were thereupon set up. The object of both committee and council was to be the establishment of "a permanent organization for the promotion of industrial scientific research." Thus was recognized the necessity for organizing the national brain power in the interests of the nation at peace. War has remained as much an art as ever, but its instruments are now not only forged by the man of science, but they need a scientific training for their effect-

ive use. This, the report says, is equally true of the weapons of industry. The brains, even the very processes, that to-day are necessary to the output of munitions were yesterday needed, and will be needed again to-morrow, for the arts of peace. The council was faced from the first with the fact that the war had greatly reduced the number of workers available for research, and it found that certain researches conducted or directed by professional associations in the period preceding the war stood in grave jeopardy of enforced abandonment. The first act of the council, therefore, was to save as many derelict researches as possible; its second was to confer with professional and other societies concerned, especially with chemical and electrical industries; its third to form a register of researches; its fourth to aid research in educational institutions, and its fifth to form the standing committees already mentioned. The appointment of other standing committees is in contemplation. The sphere of universities and technical colleges in relation to the work with which the council is concerned is discussed, and finally certain general conclusions are drawn. The first is that a largely increased supply of competent researches must be found, and the second, that there must be a hearty spirit of cooperation among all concerned, men of science and of business, working men, professional and scientific societies, universities and technical colleges, local authorities, and government departments. It was found that the output of the universities before the war was altogether insufficient to meet even a moderate expansion in the demand for research. It is hinted that hitherto the scientific army in Great Britain has consisted of a brilliant group of staff officers, and it is bluntly said that we have not yet learnt how to make the most of mediocre ability, though without scientific rank and file it will be as impossible to staff the industrial research laboratories that are coming as to fight a European war with seven divisions. The council expects to be able to encourage a longer period of training by the offer of research studentships, but "it is useless to offer scholarships if competent candidates are not forthcoming, and they cannot be forthcoming in sufficient numbers until a larger number of well-educated students enter the universities. That is the problem which the education departments have to solve, and on the solution of which the success of the present movement in our opinion largely depends." The council considers that the organization of research in the interest of various industries must be coordinate. "It must be continuous in its operation, and its ramifications will spread as knowledge grows. It will inevitably tend to bring industries into intimate relation which are at present independent of each other; to transform what have hitherto been crafts into scientific industries; and to require cooperation, not only between different firms in the same industry, but between groups of industries in a continuously widening series of interrelated trades. The forces which are at work in this direction have elsewhere found their expression in connection with the trust and the combine; but we believe, if the real nature of these forces is clearly grasped, that it will be possible to organize them for the benefit, not only of the industries, but of the nation as a whole."—*The British Medical Journal.*

SCIENTIFIC BOOKS

Annals of the Dearborn Observatory, Northwestern University. Volume I., Historical and Descriptive Introduction, Measures of Double Stars. By PHILIP FOX, director of the observatory. Published at Evanston, Illinois, 1915. 4to. Pp. 229.

Science often moves along paths that soon become obscure to the eye of the historian. He can always trace the course of the highways, marked as they are by published contributions. But he may easily miss the almost equally important though less conspicuous byways through the quiet places—the influence of a great teacher, or the silent force of an example of devotion. He who seeks to account for the great activity in America along the lines of observational astronomy must not overlook or underestimate the part that Burn-

ham has played in this movement. He has planted in two of our great observatories a tradition of faithful observing that will long endure; and from these two institutions the same tradition has been transplanted to smaller and to newer observatories. We are reminded of this by Professor Fox's dedication of this first volume of annals from the Dearborn Observatory: "to Sherburne Wesley Burnham, who spared not himself in his oft heroic vigils, whose personal encouragement has been the direct inspiration for these observations." These words might have been as fittingly written by many another astronomer.

Only a few of the world's great telescopes are used to their full capacity, and most of these few are to be found on this side of the Atlantic. Among them must now be counted the Dearborn telescope, which has been used whenever the sky has permitted on almost every night since the fall of 1909, a date that marks the advent of the present director. This is a remarkable record, for during most of this time Professor Fox has worked single handed, and at no time has he had more than one assistant. Moreover, in addition to his work at the telescope he has fulfilled various administrative duties and has taught classes at the Northwestern University. It is clear that the Dearborn telescope, though it is a beautiful and efficient instrument, is not at present the chief asset of the Dearborn Observatory.

The introduction to this volume contains an historical account of the observatory, beginning with the formation of the Chicago Astronomical Society in 1862, the purchase immediately afterward of the 18½-inch telescope, the early struggle for existence, the almost fatal blow dealt by the great fire of 1871, and finally the happy affiliation in 1887 with the Northwestern University. The telescope was for a time not only the largest in the world but probably also the finest. Its excellent qualities have been proven by the discovery of the companion to Sirius (while still in the hands of its makers, Alvin Clark and Sons); by a long list of measures of difficult objects by Burnham, Hough and Fox; by the excellent photographs that have recently been made with it; and most convincingly of all, by the results of an application to it of the Hartmann tests. Professor Fox carried out these tests in 1912 and 1913 and describes them fully here. They show that when the objective is at its best there is practically no spherical aberration. They also indicate that under certain temperature conditions a considerable amount of aberration may be temporarily present, the effect being similar to the phenomena that the reviewer showed to exist in the case of the Thaw telescope at Allegheny and in one or two other very large refractors. This effect is correlated, not directly with the actual temperature, but rather with the rapidity with which the temperature has changed in the interval immediately preceding the making of the test.

Two chief investigations are now being carried out with this telescope, the determination of stellar parallaxes by photography, and the systematic measurement of double stars. It is to the latter that the present volume is devoted. The random discovery of new double stars or the casual measurement of the best known doubles, does not add much to the progress of this branch of astronomy. Professor Fox has wisely adopted an observing program made up of definite lists of stars that would not be likely to receive attention otherwise. The volume before us is chiefly concerned with the double stars discovered by Holden, with those discovered by Küstner, and with a selected list from Burnham's General Catalog. Much care was expended on the arrangement and printing of the observations, so that the volume is not only a beautiful example of the printer's art, but is one that leaves nothing to be desired on the score of convenience of reference.

Some of the pairs in this volume were measured not only with the Dearborn telescope, but earlier also with one or both of the Yerkes refractors of 12 and 40 inches aperture, respectively. The comparison of the measures of the same object made by the same observer is very instructive. The reviewer has collected all such cases in the volume and has arranged

them in the order of the angular separation of the two components. We thus get the following means, the number in parentheses indicating how many pairs are included in each mean:

MEASURED SEPARATIONS

With the 12-Inch	With the 18½-Inch	
″	″	
0.94	1.14	(5)
1.80	1.96	(5)
2.34	2.43	(5)
3.29	3.32	(5)
4.18	4.25	(5)

With the 12-Inch	With the 40-Inch	
″	″	
0.68	0.85	(5)
1.13	1.34	(6)
1.71	1.87	(4)
2.05	2.22	(6)
2.55	2.57	(5)
3.96	4.03	(8)
4.65	4.66	(6)

With the 18½-Inch	With the 40-Inch	
″	″	
0.83	0.88	(5)
1.54	1.59	(6)
1.98	1.93	(6)
2.45	2.50	(6)
3.54	3.55	(6)
4.34	4.29	(7)

Measures made with the two large telescopes show little or no systematic difference, but those made with the 12-inch yield smaller separations than either of the others, the difference being largest for small separations and becoming negligibly small for separations in the neighborhood of 5″.

In the recently issued Volume 12 of the Publications of the Lick Observatory, Professor Aitken gives a long list of measures of double stars. Many of these were examined with both the 12-inch and the 36-inch telescopes of that observatory, so that we have an opportunity for making the same kind of tests as on Professor Fox's observations. The results similarly collected are as follows:

MEASURED SEPARATIONS

With the 12-Inch	With the 36-Inch	
″	″	
0.52	0.42	(20)
0.62	0.54	(25)
0.71	0.64	(20)
0.81	0.79	(24)
1.07	1.03	(24)
1.38	1.39	(21)
2.13	2.10	(26)
4.49	4.53	(18)

Here again we have a systematic difference that increases as the separation becomes smaller. But in Professor Aitken's measures the difference has the opposite sign from Professor Fox's, the measures with the smaller telescope coming out larger than with the greater telescope. It would be interesting to know whether these are instrumental peculiarities or whether they have their origin in the habits of the observers. In any case it seems likely that a discussion of the systematic errors of telescopes and observers would be well repaid in the additional accuracy with which double-star orbits could be computed after the application of systematic corrections. Some attempts at such a study have been made, but (so far as the reviewer is aware) none of them is as thorough as the importance of this matter warrants. Needless to say that the presence of systematic errors of this kind is evidence for the skill and the care of the observer rather than against. In the work of an inexperienced or careless observer, such small effects as these would be buried under an accumulation of accidental errors.

FRANK SCHLESINGER
ALLEGHENY OBSERVATORY OF THE
UNIVERSITY OF PITTSBURGH,
September 30, 1916

The Sessile Barnacles (Cirripedia) contained in the Collections of the U. S. National Museum; including a Monograph of the American Species. By H. A. PILSBRY. Bulletin 93, U. S. National Museum, 1916.

In this great work, of 366 pages with 76 plates, Dr. Pilsbry brings the American sessile barnacles out of obscurity, and furnishes the means whereby all who will may continue the investigation of the group with as much ease as the nature of the subject permits. A critical review of the book could only be written by one who had covered at least a considerable part of the field by his investigations, and at present Dr. Pilsbry stands alone in this country in his knowledge of barnacles, with no

one competent to criticize his results in any detail. All we can say is that we recognize the same lucidity and fullness of treatment, and the same broadly philosophical point of view, which have long been familiar in the writings of the author on Mollusca. Adding to this the beautiful and abundant illustrations, it seems that there is nothing left to be desired.

To the general zoologist, perhaps the most interesting part will be that in which the work of Darwin on barnacles is reviewed. Darwin wrote about sixty years ago, and to-day Dr. Pilsbry has this to say of his work:

"His grasp of detail was so comprehensive and his language so lucid that one can not expect to improve upon them. In the field he covered one can not do better than to imitate. Yet it has been possible to extend the work in certain directions."

"His monograph on the subclass Cirripedia is one of the most brilliant morphologo-systematic studies to be found in the whole field of systematic zoological literature."

Under *Balanus* (p. 50) we read:

"It is a remarkable testimony to Darwin's insight and restraint that every one of the species of *Balanus* admitted by him is still accepted as valid."

Under Coronulinæ (p. 269):

"We owe to him a discussion of the morphology of the group so lucid that no subsequent student has been able to add anything of importance."

Under Chthamalidæ (p. 292):

"We owe the establishment of this family solely to the taxonomic genius of Darwin, who first brought the genera together and demonstrated their relationship. I have examined and dissected many more species, I suppose, than any one else, and I find all of the evidence supports Darwin's views."

Thus, had Darwin never been known as a great philosophical naturalist and evolutionist, he would still have stood in the front rank as a brilliant taxonomist and morphologist.

One of the important facts brought out by Dr. Pilsbry is that the so-called cosmopolitan barnacles, when belonging to the littoral or shallow-water fauna, present numerous subspecies which conform in general to the faunal provinces already recognized for other marine animals. In general, also, the distribution of species is more restricted than has been supposed, as it is found that many of the records are taken from specimens attached to ships, far out of their natural range.

It appears that the British Museum, which contains Darwin's types and the *Challenger* materials, has the most important collection of barnacles in existence. Second to this is the U. S. National Museum, which possesses no less than 76 types.

T. D. A. Cockerell

University of Colorado,
September 3, 1916

SPECIAL ARTICLES

ANTAGONISTIC SALT ACTION AS A DIFFUSION PHENOMENON

1. The writer pointed out in 1905[1] that the antagonization of the toxic action of NaCl by $CaCl_2$ (or in general of salts with univalent cation by small quantities of a salt with bivalent cation) was due to the Ca preventing the diffusion of the NaCl through the membrane of the cell. It is often difficult to decide whether or not the antagonistic salt action is a diffusion phenomenon or a phenomenon due to the action of the salt upon the living protoplasm. We possess, however, one object in which definite proof can be furnished that the antagonistic salt action is merely a diffusion phenomenon, due to a direct action of one (or both salts) on the membrane and not on the protoplasm; namely, the egg of *Fundulus*. In this case the embryo is the living protoplasm and by comparing the action of salts on the egg, while the embryo is still inside, with the action of the same salts when the embryo is freed from the membrane, we can make sure that the phenomena of antagonization observed in the egg of *Fundulus* are diffusion phenomena. This may be illustrated by a few simple examples.

[1] Loeb, J., *Arch. ges. Physiol.*, 1905, CVII., 252.

In his paper of 1905 the writer pointed out already that $ZnSO_4$ retards the injurious action of a $m/2$ or $5/8\ m$ solution of NaCl upon the embryo inside the egg, while the newly hatched fish dies more rapidly in a $m/2$ or $5/8\ m$ NaCl solution when a trace of $ZnSO_4$ is added; and that this fact was only comprehensible on the assumption that the antagonistic action of the $ZnSO_4$ in the former case was due to an action of this salt upon the membrane, whereby the rate of diffusion of the NaCl through the membrane was diminished.

When we put eggs of *Fundulus* from six to ten days old into a $3\ m$ NaCl solution the embryos are killed and coagulate inside of five hours, for the reason that in this concentration the NaCl is able to diffuse through the membrane, which is practically impermeable to water as well as to balanced salt solutions of not too high a concentration. When we add 1 c.c. $10/8\ m$ $CaCl_2$ to 50 c.c. $3\ m$ NaCl, the embryo will keep alive (as indicated by the continuation of heartbeat, circulation, and spontaneous motions of the whole embryo) for from three to five days.[2] This prolongation of life through the addition of Ca is due not to an action upon the protoplasm but to a prevention of the diffusion of the NaCl into the egg, since if we take the embryo out of the egg (or use the newly hatched embryo) it is killed in 50 c.c. $3\ m$ NaCl + 1 c.c. $10/8\ m$ $CaCl_2$ inside of a few minutes. The antagonistic effect of the $CaCl_2$ consisted therefore in this case in the Ca modifying the egg membrane in such a way as to retard the diffusion of NaCl through the membrane. Since the objection might be raised against this conclusion that a slow diffusion of Ca into the egg counteracted the effects of an almost equally slow diffusion of NaCl upon the fish itself, we may add that the experiment succeeds just as well if the $CaCl_2$ is replaced by $MnCl_2$, which is not able to counteract the injurious action of NaCl upon the embryo outside the egg, while it counteracts the injurious action of NaCl upon the embryo while the latter is inside the egg. The antagonistic action of Ca or Mn or $ZnSO_4$ (or any salt with bivalent cation) upon the injurious action of a NaCl solution consists, therefore, in the case of the egg of *Fundulus*, purely in the prevention or retardation of the diffusion of NaCl through the membrane of the egg.

[2] Loeb, J., *Biochem. Ztschr.*, 1912, XLVII., 127.

KCl is a general nerve and muscle poison and causes cessation of the heartbeat in comparatively low concentrations. When we put the eggs of *Fundulus*, after heartbeat and circulation are established, directly from sea-water into $m/8$ KCl the hearts stop beating in a few hours. If, however, the $m/8$ KCl solution is made up in $m/1$ NaCl + $CaCl_2$ the embryo may live in the solution for ten days or more. That we are dealing in this case of antagonism also with a diffusion phenomenon is made certain by the fact that the combination $NaNO_3 + MnCl_2$ is practically as good an antagonist against KCl as is $NaCl + CaCl_2$, as long as the embryo is in the egg; while when it is out of the egg the mixture $NaNO_3 +$ $MnCl_2$ (as well as $NaNO_3$ or $MnCl_2$ alone) is unable to antagonize KCl.

These examples, to which many others might be added, show that the phenomena of antagonism described by the writer for the egg of *Fundulus* are purely diffusion phenomena and due to a direct action of the salts on the membrane of the egg and not due to an action of the salts upon the protoplasm of the embryo.

2. The experiments on the egg of *Fundulus* give us therefore an unusual advantage, inasmuch as they allow us to decide with certainty whether the phenomena of antagonism are diffusion phenomena or phenomena due to the action of salts upon the protoplasm; since we can easily separate the protoplasmic part of the egg—the embryo—from the membrane. On account of this unusual advantage the writer has made this object the basis of his work on the theory of physiologically balanced solutions. When we deal with cells whose membranes we can not remove at desire we have a reason to doubt whether or not the phenomena of antagonistic salt action are also of the order of diffusion phenomena. The observations of the writer on the fish itself seem to indicate that phenomena of diffusion enter

here just as well, since there is a far-reaching parallelism between the rules of antagonism for the isolated fish and the egg. Thus Loeb and Wasteneys have shown that the fish *Fundulus* dies more slowly in a pure $m/100$ or $m/50$ KCl solution than when 10 molecules of NaCl are added to 1 molecule of KCl; while the toxic action of KCl is prevented when 17 or more molecules of NaCl are added to 1 molecule of KCl.[3] The writer has recently found that the same fact is true for the eggs of *Fundulus,* with this difference only, that much higher concentrations of KCl are required to demonstrate the phenomenon in the egg than in the fish; and that a much wider range of antagonistic salts can be used in the case of the egg than in that of the fish. This difference, however, can easily be accounted for by the difference between the membrane of the egg and the skin of the fish.

The fact that the stimulating action of salts upon nerve and muscle is inhibited by Ca may also be due to the prevention of the diffusion of the stimulating salts into the nerve or muscle by the Ca.[4]

The writer is in no position to state whether or not Osterhout's[5] interesting observations on the electric conductivity of *Laminaria* may be interpreted as diffusion phenomena, since it is not possible in that object to separate the direct action of the salts on the membrane from that upon the protoplasm. The death of a cell under the influence of a salt must be ascribed to an action of the salt upon the protoplasm, but this action can only take place after the salt has been able to diffuse through the membrane.

The diffusion of certain electrolytes through a membrane seems to depend in addition to the osmotic pressure of the salt in solution upon a second effect which the writer has called the general salt effect.[6] This effect he attributes to a combination of the salt with certain constituents of the membrane, presumably proteins.

3. There are certain kinds of antagonism which seem peculiar to phenomena of irritability and which can not be found in phenomena of diffusion. Thus the larvæ of the barnacle are unable to swim when put into a mixture of $NaCl + KCl + CaCl_2$ until some $MgCl_2$ is added; they are also unable to swim in a mixture of $NaCl + KCl + MgCl_2$ without $CaCl_2$.[7] It is not strictly correct to call this a case of antagonism between Ca and Mg, since in mixtures of $CaCl_2$ and $MgCl_2$ (without $NaCl +$ KCl) the animals are no more able to swim than in a mixture of NaCl and KCl alone or of $NaCl + KCl + MgCl_2$. Either Ca or Mg suffices to counteract the diffusion of $NaCl +$ KCl through the membrane of *Fundulus,* and it is not necessary to add both. The writer had first observed this type of antagonism in the rhythmical contractions of the jellyfish *Polyorchis*[8] and it was afterwards observed by Meltzer and Auer in mammals.[9] It may be peculiar to special sense organs or other animal structures since the writer was not able to observe it in *Euglena.* JACQUES LOEB

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[3] Loeb, J., and Wasteneys, H., *Biochem. Ztschr.*, 1911, XXXII., 155.

[4] Loeb, J., and Ewald, W. F., *Jour. Biol. Chem.*, 1916, XXV., 377.

[5] Osterhout, W. J. V., SCIENCE, 1916, XLIV., 395.

[6] Loeb, J., *Proc. Nat. Acad. Sc.*, 1916, II., 511.

[7] Loeb, J., *Jour. Biol. Chem.*, 1915, XXIII, 423.

[8] Loeb, J., *Jour. Biol. Chem.*, 1905–06, I., 427.

[9] Meltzer, S. J., and Auer, J., *Am. Jour. Physiol.*, 1908, XXI., 400.

THE ELECTRICAL CONDUCTIVITY OF SOLUTIONS AT DIFFERENT FREQUENCIES

V.[1] ON THE MEASUREMENT OF THE TRUE AND APPARENT ELECTRICAL CONDUCTIVITIES AND THE INDUCTANCE, CAPACITY, FREQUENCY AND RESISTANCE RELATIONS

FOR the past two years the authors have been engaged in a detailed study of the passage of alternating currents at different frequencies through solutions of electrolytes. For a source of current we have used several generators but especially the Type *B* Vreeland

[1] Summary of a paper given at the Urbana meeting of the American Chemical Society, April 18, 1916.

oscillator sold by the Western Electric Company, as it gives a pure sine wave form and the frequency of the current can be varied at will over a range of 160 to 4,200 cycles. We have also arranged with Vreeland for Leeds and Northrup to sell a smaller instrument giving 500, 750, 1,000 and 1,500 cycles per second.

Curtis coils were used in our bridge, as by this means we could practically eliminate inductance and capacity effects which are a source of error when inductive resistances are used. Tuned telephones sold by the Western Electric Company were used so that the minimum could be detected as accurately as possible.

Several different bridge arrangements have been used for measuring the capacities, inductances and resistances. In order to measure a "cell constant" it is necessary to determine both the resistance and the capacity given by the standard solution of ($N/10$, $N/50$, $N/1,000$) potassium chloride at different frequencies. A substitution method suggested by Curtis for measuring resistances was used, as it prevents errors due to any changes in the resistances of the bridge coils, or of the inductance, caused by variations in temperature, and allows the experimenter to read the resistances directly instead of having to make involved calculations.

Resistance measurements made on a given solution in a given cell by using (1) an inductance in series with the cell and (2) a condenser in parallel with the resistance arm checked to within 0.001 per cent. when all necessary corrections are made.

We have used a new type of cell in which each electrode is supported in four places, so that it can not move and thus change the cell constant. We have also made all joints to come below the surface of the water so that there can be no error from evaporation of the solvent. One criterion of good cells is that *whatever the solutions used the ratios of the resistance of any solution in two such cells, or of two solutions in any cell, must be constant to within 0.01 per cent. at infinite frequency.*

It was found that resistance readings on a given cell with a given solution can be repeated easily with an average deviation within $\pm$ 0.001 per cent.

Even in the old type cells, and when no special precautions were taken in transferring the solutions, resistance measurements on different parts of the same solution in the same cell checked to within 0.01 per cent.

When solutions of electrolytes were allowed to stand in cells for 24 hours, the resistance of the solution in the cells with platinized electrodes did not change, while in those with bright electrodes the resistance increased at the rate of about 0.003 ohm per hour.

There is no measurable change in the resistance of a solution, or the capacity of the cell, with change in voltage from 0.25 to 8 volts, provided the cells, solutions and containers are kept scrupulously clean, and the polarization voltage is kept below 1.23 volts. Dr. G. H. Gray is studying this problem by the use of the oscillograph.

The capacities in cells with bright electrodes vary from 10 to 1,000 microfarads, while in cells with platinized electrodes they range from 500 to 5,000 microfarads.

There is no measurable change in the resistance of a solution with change in frequency from 600 to 2,000 in our cells with *platinized electrodes* 1 inch in diameter, and such cells therefore give approximately the true electrical resistance of solutions at any such frequency. The ratios of the resistances of $N/5$, $N/10$ and $N/20$ NaCl measured in two different cells with platinized electrodes show a deviation of not over 0.01 per cent. at these frequencies, which is hardly more than the experimental error.

In cells with *bright platinum electrodes* there is a change in resistance with change in frequency from 250 to 3,000 cycles and higher, and this change depends upon several factors: (1) As the concentration of any given solution is decreased, and therefore the resistance increased, the change in resistance with change in frequency is decreased; (2) as the area of the electrode surface is increased the change in resistance with change in frequency is decreased; (3) as the area of the electrode surface is increased the inductance necessary to

obtain a balance is decreased, and hence the apparent "capacity" of the cell is increased; (4) the higher the apparent "capacity" of the cell, the smaller the change of resistance with change in frequency; (5) solutions of different salts having about the same resistance in the same cell give approximately the same change in resistance with change in frequency from 600 to 1,000 cycles.

By comparing the resistances of $N/10$ and $N/20$ NaCl in two cells, one of which had bright and the other platinized electrodes 1 inch in diameter, it was seen that the ratio for the cell with bright electrodes was much lower than that for the cell with platinized electrodes, but as the frequency was increased the ratio for the cell with bright electrodes approaches that for the cell with platinized electrodes. Extrapolating the resistance for the cell with bright electrodes to infinite frequency, the ratio was found to differ by only 0.01 per cent. from that given by the platinized electrodes. It is thus shown that the true electrical resistance of solutions can be measured or calculated in cells with bright platinum electrodes only at infinite frequency.

Saturation of bright and platinized electrodes with hydrogen produces no appreciable change in the "capacity" of the cell at 60 cycles. This and much other evidence seems to show that the "capacity" does not arise from a neutral gas layer deposited on the electrodes and acting as an air condenser. It is probably due to a "double layer" of the electrolyte and the "contact potential" arising from changes of concentration resulting from electrolysis and to the reverse electromotive force coming from the deposition of ions on the electrodes.

The inductance necessary to balance the "capacity" of the cell is nearly but not quite inversely proportional to the square of the frequency. As this relation holds true for a "leaky" condenser the cell seems to act as a simple condenser with a "leak."

As the frequency of the alternating current is increased the change in resistance of a given solution in a given cell, and also the inductance necessary to balance the capacity of the cell, are decreased, and both approach zero at infinite frequency. The ratio of the difference in the inductance in millihenries to the difference in the resistance in ohms between 600 and 1,000 cycles has a constant value of about 2.00.

Mr. Henry P. Hastings is continuing the work by making measurements of resistance, capacity and inductance at much wider range of frequency, namely, 60, 250, 500, 750, 1,000, 1,500, 2,000 and 3,000 cycles. He has confirmed the fact that a change in frequency produces a change in inductance necessary to balance the cell capacity which corresponds fairly closely to the equation $KL = 1/Cw^2$. At lower frequencies he observes easily a third harmonic produced by the cell. Mr. Hastings has also confirmed our work by extrapolating the resistances of solutions in cells with bright electrodes to infinite frequency and showing that they approach the values given by the same solutions in cells with platinized electrodes.

He has also found that the ratio of the *change of resistance* which is sometimes 5 per cent. of the resistance, to the *change of inductance* produced when the frequency is changed is approximately constant.

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ON THE REGULARITY OF BLOOMING IN THE COTTON PLANT

In 1915 the writer carried on some experiments on the water requirement of cotton, in connection with which the blooming records of a number of plants were kept. In looking over these records, there appears to be a sort of regularity in which the blooms opened and two of these records which showed the greater regularity are herein given.

To those unacquainted with the habit of growth of the cotton plant it will be well to first call attention to the different kinds of branches as shown on the accompanying diagrams. On the one of plant No. XIV., those branches numbered one and two are known as vegetative branches; these occur on all plants of this species so spaced as to have freedom in

growth but are often aborted when the plants are crowded, much as are the lower branches of trees in a crowded forest. From each node of these branches secondary fruiting ones grow in a similar manner as do the primary fruiting branches from the main stalk, although the inner ones may be thrown off on account of the dense shade, as will be noted from the diagram.

strength of the plant will be thrown into the fruiting ones and a greater and earlier crop will result.

Out from nodes number six, seven and eight, will be noticed some secondary vegetative branches; from these also fruiting branches occur as from the primary. On small plants, dwarfed from lack of water or of plant food, these are usually wanting but may occur on

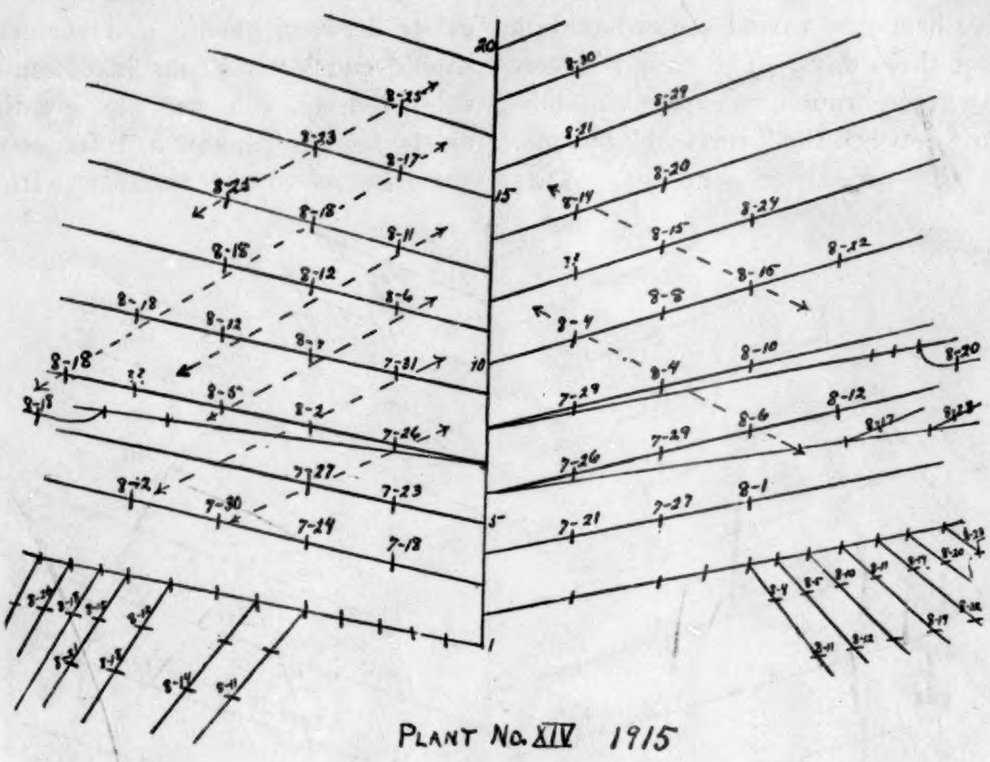

FIG. 1. PLANT NO. XIV.

Above the vegetative branches, coming out from nodes three to eighteen are the primary fruiting branches. The bolls on these are larger and earlier than those found on the secondary fruiting branches mentioned above as well as on those yet to be mentioned; from the complete record of this plant it was noted that seventeen bolls opened on the primary branches before any opened on the secondary. Farmer's Bulletin No. 601 explains a new system of cotton culture which is based on this fact and on that of the abortion of the vegetative branches, mentioned in the preceding paragraph. The claim is made that with thicker planting, late thinning, and by leaving more plants per acre than is usually done, the vegetative branches will be aborted, the plants having good conditions of environment or may come out as a result of topping or other injury to the plant. The diagram shows no true branching of either vegetative or fruiting branches. Mr. O. F. Cook in Bul. No. 198 of B. P. I. says:

> Pruning or other injury, or renewed growth in late season may cause the formation of secondary limbs from primary limbs, or even from axillary buds of fruiting branches.

He further points out that vegetative branches ordinarily arise from axillary buds and fruiting branches from extra-axillary ones. For other variations in the branching or in the location of the flower bud, the reader is referred to this publication. In these dia-

grams, the branches are shown necessarily as alternate, although occurring on the plant in a spiral.

On the main fruiting branches, there appears normally a single bloom at each node. In the diagram of plant No. XIV., it is shown that the blooming began on the third branch (first fruiting branch) on July 18 and ended on the eighteenth branch on August 30. The intervals between the blooming of the first nodes on consecutive branches varied somewhat, but averaged about three days. The time between blooms on any given branch was approximately double the time between the "vertical" blooms, as given in the preceding sentence. This relation was carried out with the other blooms on any given branch. To put it in other words, *there is an apparent relation,* indicated by the broken arrows on the diagrams, *between the blooms on any one branch and those on the second higher one, in that any given bloom has a tendency to appear at the same time as the one on the second higher branch, one node nearer to the main stalk.*

This regularity occurred on plants of the Cleveland Big Boll variety, grown in potometers. Plant No. XIV. was grown in soil the water-saturation of which was maintained at 90 per cent. Plant No. XXIV. was grown in soil the saturation of which was maintained at 60 per cent. and shows even more than the other this regularity in blooming.

Conditions of environment, such as the water content of the soil, the amount of available plant food, the day and night temperatures, sunniness or cloudiness, theoretically would influence the length of time which exists between blooms and variations in these should cause variations in blooming in plants subjected to the varying conditions; there exists also, no doubt, a difference in different varieties as to the rapidity with which they bloom, but granting this, it is likely that the relation which is pointed out would even then very likely hold true.

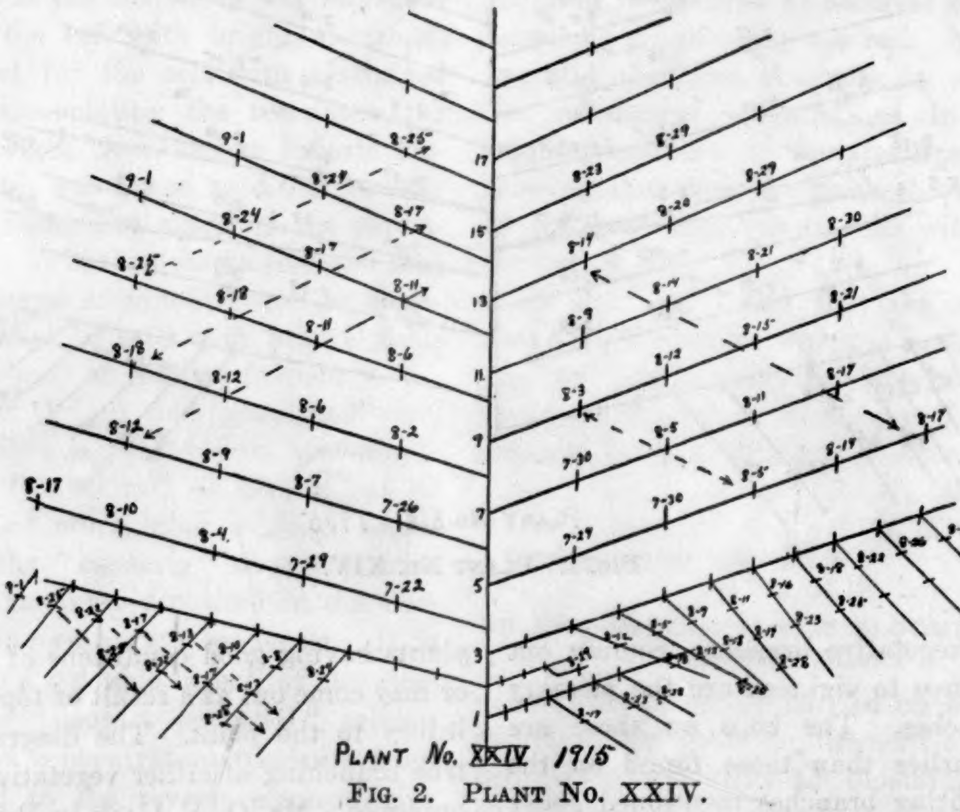

FIG. 2. PLANT NO. XXIV.

As stated, these diagrams are of the two plants which show the regularity to the greatest degree. They show also many instances in which the bloom appeared not on the same day, but one day later than on the second branch above and one node nearer to the main stalk. Then there are many examples showing great irregularity. It would seem that this points to a very interesting field of study on

what is the *order of blooming* in the cotton plant, the normal *time between blooms* both vertically and horizontally, the *inherent tendencies* toward regularity or irregularity of different varieties, and the factors which influence or determine these things.

C. K. McCLELLAND

GEORGIA EXPERIMENT STATION

THE SAN DIEGO MEETING OF THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE first annual meeting of the Pacific Division of the American Association for the Advancement of Science was held in San Diego, California, between the dates, August 9 and 12. The headquarters for the meeting were maintained in the U. S. Grant Hotel, and the three evening sessions of the meeting were held in the assembly room of the hotel. For the day sessions of societies participating in the occasion convenient meeting places were provided in the San Diego High School by courtesy of the Board of Education of San Diego.

The first of the general sessions of the San Diego meeting was held on Wednesday evening, August 9, Dr. W. W. Campbell, president of the Pacific Division, presiding. Hon. Lyman Gage, of San Diego, spoke in welcome on behalf of the citizens of San Diego, and Dr. D. T. MacDougal, chairman of the executive committee of the Pacific Division, responded on behalf of the Division. These addresses were followed by the address of the president of the Division, Dr. W. W. Campbell, director of the Lick Observatory, Mount Hamilton, upon the subject, "What We Know about Comets," illustrated by stereopticon. After this session a reception, given under the auspices of the honorary reception committee for the San Diego meeting, was tendered to the visiting members of the American Association and of other societies participating in the meeting.

The second general session of the Division was held on Thursday evening, August 10, Dr. D. T. MacDougal, chairman of the executive committee of the Pacific Division, presiding. At this session the executive committee of the Division was reelected to serve for the ensuing year, upon nomination by a duly appointed nominating committee. The members reelected at this time were:

E. C. Franklin, professor of chemistry, Stanford University.

T. C. Frye, professor of botany, University of Washington.

C. E. Grunsky, consulting engineer, San Francisco.

G. E. Hale, director of the Mount Wilson Solar Observatory, Carnegie Institution of Washington, Pasadena.

V. L. Kellogg, professor of entomology, Stanford University.

A. C. Lawson, professor of mineralogy and geology, University of California.

E. P. Lewis, professor of physics, University of California.

These seven elected members, together with the president and the vice-president of the Division, elected by the committee, constitute the executive committee of the Division.

Following the transaction of this business, an address was given upon the subject, "Modern Natural History Museums, and their Relation to Public Education," by Dr. Barton W. Evermann, director of the museum of the California Academy of Sciences, San Francisco. This address was illustrated with stereopticon views of animal habitat groups which are being installed in the museum of the California Academy of Sciences.

The third general session of the Division was held on Friday evening, August 11, Dr. W. W. Campbell, president of the Pacific Division, presiding. At this session the following resolutions, presented by the Western Society of Naturalists, were unanimously endorsed:

IN VIEW OF THE FACT that the great natural resources of the sea in this part of the world, long known to naturalists, are beginning to be utilized; and

IN VIEW OF THE FACT that these developing industries, notably those of tuna fishing and kelp harvesting, are making conspicuous many problems of great interest, both industrial and scientific, the solution of which is possible only by long and somewhat expensive investigation;

Resolved, that the Western Society of Naturalists urges upon the attention of the government of the United States and the state of California the importance of giving such support, financial, legislative, administrative and otherwise, as may be necessary to place the various sea industries on a thoroughly scientific foundation; and

Resolved, that a committee of five, four from this society and one from the industries be appointed to act in cooperation with other representatives of the industries for the furthering of the ends indicated in these resolutions.

Resolved, that these resolutions be presented to the Pacific Division for its consideration with the hope that its approval may be given.

Following the business of this session an address was presented upon the subject, "The Physician of To-morrow," by Dr. F. F. Wesbrook,

president of the University of British Columbia, Vancouver.

The societies holding meetings on this occasion were the Astronomical Society of the Pacific, the Cordilleran Section of the Geological Society of America, the Western Society of Naturalists, the Pacific Slope Branch, American Association of Economic Entomologists, and the Ecological Society of America. The San Diego Society of Natural History and the Pacific Coast Branch of the American Phytopathological Society also participated in the meetings of the Western Society of Naturalists.

On Friday afternoon, the Women's Board of the Panama-California International Exposition received visiting members of the American Association and of participating societies in the rooms of the board in the California building on the exposition grounds.

The period of the meeting was closed, except for excursions, by a dinner held on the evening of Saturday, August 12, in the U. S. Grant Hotel. At this dinner, Mr. Edward L. Hardy, president of the California State Normal School at San Diego, presided, and addresses were presented by Dr. W. W. Campbell, director of Lick Observatory, Mount Hamilton, California; Dr. John C. Merriam, professor of paleontology and historical geology, University of California; Dr. F. F. Wesbrook, president of the University of British Columbia, Vancouver; and Dr. F. R. Burnham, San Diego.

During the days following the meeting, excursions were arranged as follows:

Through the courtesy of the United States Bureau of Fisheries, the *U. S. S. Albatross* was in port at San Diego during the period of this meeting, and was made available for a demonstration trip on the morning of Saturday, August 12.

Automobiles were provided, through the courtesy of the San Diego Chamber of Commerce, for an excursion to the works of the Western Salt Company, South San Diego, and to the Otay Valley and the Coronado peninsula, on Saturday morning, August 12.

An excursion was arranged on the afternoon of Saturday, August 12, under the auspices of the Ecological Society of America, including in its itinerary the Scripps Institution for Biological Research near La Jolla, an isolated colony of Torrey pines, six miles north of La Jolla, and the beach near the Scripps Institution.

On Sunday, August 13, through the courtesy of the Hercules Powder Company and of Swift and Company, opportunity was afforded members of the association and participating societies to inspect the processes of the chemical reduction of kelp at the plants recently established in San Diego by these two concerns.

A notable excursion occupied Sunday and Monday, August 13 and 14, in which, as guests of the San Diego Society of Natural History, a party of thirty-two was conducted by automobile through the mountains of the central part of San Diego County to the edge of the Colorado Desert, accomplishing a trip of over two hundred miles. Saturday night was spent in camp in the mountains at the edge of the desert.

In the provision for these excursions, the Pacific Division of the American Association is greatly indebted to Mr. E. W. Scripps, of Delmar, San Diego County, for donating a fund from which a great portion of the expense of these excursions was defrayed. The fund placed these excursions within the reach of a large number of visiting members.

On Wednesday afternoon, August 9, the dedication of the recently completed museum and library building and the concrete wharf was held at the Scripps Institution for Biological Research at La Jolla. At these exercises Dr. Benjamin Ide Wheeler, president of the University of California, presided. The invocation was given by the Rt. Rev. Joseph H. Johnson, bishop of Los Angeles, and the following addresses were presented:

The Training of Scientific Men, David Starr Jordan, chancellor emeritus of Stanford University, California.

Biological Research Institutions: Organization, Men and Methods, D. T. MacDougal, director of the department of botanical research, Carnegie Institution of Washington, Tucson.

The Sources of the Nervous System, G. H. Parker, professor of zoology, Harvard University.

What the Scripps Institution is Trying to Do, William E. Ritter, scientific director, Scripps Institution for Biological Research, La Jolla.

The total registered attendance at the San Diego meeting included ninety members of the association and of participating societies from outside San Diego, and thirty members from San Diego and vicinity; making a total of one hundred and twenty. The total number of sessions was sixteen. In addition to the registered attendance, several of the sessions received a large general attendance from San Diego.

Albert L. Barrows,
Secretary, Pacific Division